ARCHIVES OF OTOLARYNGOLOGY

VOLUME 23 APRIL 1936 NUMBER 4

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ESOPHAGITIS

I. ANATOMY AND PHYSIOLOGY AND A REVIEW OF THE LITERATURE

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The incidence of esophagitis, in comparison to other diseases, has always been comparatively small. Nevertheless, there has been observed at postmortem examinations at the Mayo Clinic during the past few years an apparent increase in the incidence of inflammation involving the esophagus. The purpose of our inquiry was to determine whether there has been a real increase in the incidence of esophagitis, to study the nature of the condition and, if possible, to ascertain the factor or factors responsible for this increase, apparent or real.

EMBRYOLOGY

In the 4.2 mm. embryo, according to Prentiss [1] (1922), the foregut is differentiated into the pharynx, trachea, lungs, esophagus, stomach, small gut and digestive glands (liver and pancreas).

In about the 6 mm. pig embryo the bronchial arches converge caudad, and the pharyngeal pouch narrows rapidly and is differentiated into the trachea and esophagus. Soon the trachea separates from the esophagus, and the esophagus widens dorsoventrally to form the stomach. There is no sharp line of demarcation between the stomach and the esophagus. The esophagus is therefore at first a simple epithelial tube, the walls of which contain three or four rows of nuclei.

In embryos of about 20 mm. vacuoles form in the epithelium. These vacuoles disappear by breaking into the lumen. This process forces the epithelium to become thinner and the lumen to increase in size. The significance of these vacuoles is not known.

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Abridgment of a thesis submitted by Dr. Butt to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Medicine.

1. Prentiss, C. E.: A Laboratory Manual and Textbook of Embryology, Philadelphia, W. B. Saunders Company, 1922, pp. 82 and 96.

Longitudinal folds of the mucosa are constant structures. In the upper third the folds are irregular and variable. In the middle and lower thirds there are four primary folds. Smaller secondary folds, variable in number, appear later at the bases of the primary folds. In the lower part of the esophagus both the primary and the secondary folds are twisted through an arc of about 90 degrees. This twisting is probably attributable to the early rotation of the stomach.

Areas of ciliated cells may be seen in the epithelium of the esophagus in embryos ranging from 55 mm. to the length at birth.

Schaffer [2] (1879) expressed the opinion that all esophageal glands are originally of the superficial type that changes to mucous glands, with some areas failing to change. Lewis and Stöhr [3] (1913) expressed the belief that glands of the superficial type develop early and are crowded down by the squamous epithelium, persisting in some areas. Both Goetsch [4] (1910) and Johnson [5] (1910) observed the cardiac glands beginning in an embryo of 78 mm. as small glandular cells in both the upper and the lower end of the esophagus. The deep glands are first seen in the 240 mm. embryo. They grow out from the epithelium and through the muscularis mucosae and lie in the submucosa. According to Goetsch, in contradistinction to the cardiac glands, the deep glandular epithelium develops after the excretory ducts have formed.

It is evident, therefore, that the superficial glands are embryologically different from the mucous glands, whether they are at the cardiac orifice or in islands at the upper end.

ANATOMY AND HISTOLOGY

In man the epithelium is of considerable thickness and varies with age, from 113 microns in the newly born to from 260 to 440 microns in the adult. Goetsch observed that the structure of the epithelium is an accurate index of the character of the food swallowed. He noted a thickened and highly cornified epithelium in animals that live on coarse food, particularly vegetable feeders, and a thin, slightly cornified epithelium in animals that live on soft food.

In man the mucous membrane of the esophagus is lined with the stratified squamous variety of epithelium. Its attached surface is

2. Schaffer, J. C.: Verirrter Magen-Epithel in der Speiseröhre, Fortschr. d. Med., 1879, p. 261.

3. Lewis, F. T., and Stöhr, Philipp: Textbook of Histology Arranged upon an Embryologic Basis, Philadelphia, P. Blakiston's Son & Co., 1913, p. 164.

4. Goetsch, Emil: The Structure of the Mammalian Oesophagus, Am. J. Anat. **10**:1, 1910.

5. Johnson, F. P.: The Development of the Mucous Membrane of the Oesophagus, Stomach, and Small Intestine in the Human Embryo, Am. J. Anat. **10**:521, 1910.

indented by the papillae of the corium; its free surface is smooth. Strahl [6] (1889) stated that these processes of the lamina propria mucosae which project into the epithelium are not true papillae but elongated ridges of lamina propria running in a direction parallel to the long axis of the esophagus and connected with one another by oblique ridges. This work was later confirmed by Goetsch. In the collapsed state of the organ its mucous membrane is thrown into longitudinal folds, or rugae, and its lumen is largely obliterated.

Beneath this epithelial covering is the corium or tunica propria of areolar tissue, which rests on a well developed muscularis mucosae. The lamina muscularis mucosae is formed of bundles of smooth muscle cells arranged longitudinally. In the upper third it may be incomplete or absent, and in the lower third it may include an inner layer of circularly disposed muscle. The midportion of the corium is penetrated by the excretory ducts of the mucous glands.

The submucous coat forms a loose layer of areolar connective tissue which unites the muscular and mucous coats. It contains lymph and blood vessels which supply the mucous membrane together with the submucous nerve plexus. The submucosa and adventitia are the only layers in the esophagus in which adipose connective tissue cells are present. They also contain the deep esophageal glands, which are closely applied to the outer surface of the muscularis mucosae.

The circular muscle, arranged in bundles, with its inner and outer connective tissue sheath lies external to the submucosa. A narrow septum of loose fibrous connective tissue lies outside the circular muscle. It contains the larger vessels and the myenteric nerve plexus. It is known as the intermuscular septum.

External to the septum is the longitudinal muscle. It is usually about half the thickness of the circular layer. In the adult it is arranged in densely packed bundles.

In the upper third the muscular coat is usually striated; the middle third is mixed, and the lower third is generally smooth. The outer fibrous coat consists of loose fibrous tissue and contains the lymph and blood vessels and the nerve trunks which supply the three inner coats. It is not invested by a serous layer.

The deep, or true, esophageal glands have a definite, uniform morphology. They are seen throughout the length of the structure, although they are more abundant in the upper half. Dobrowalski [7] (1894) observed that the whole number does not exceed two hundred, two thirds of which are in the upper half of the esophagus. They tend

6. Strahl, H., quoted by Goetsch.[4]

7. Dobrowalski, Z.: Lymphknötchen (Folliculi lymphatici) in der Schleimhaut der Speiseröhre, des Magens, des Kehlkopfs, der Luftröhre und der Scheide, Beitr. z. path. Anat. u. z. allg. Path. **16**:43, 1894.

to occur in linear groups in the long axis of the esophagus and are always beneath the muscularis mucosae. The body of the gland is ovoid, with its long axis parallel to the long axis of the esophagus. Ordinarily, it measures about 1 mm. in length. A single secretory duct, with an ampullary collecting chamber (fig. 1), forms the center of the gland and runs obliquely to the surface of the esophagus. Generally, according to Goetsch, the duct empties (fig. 2) in an aboral direction; it may, however, empty in an oral direction. The duct is at first lined by low columnar cells, which, as they approach the epithelial surface, are changed into several layers of flattened cells which form

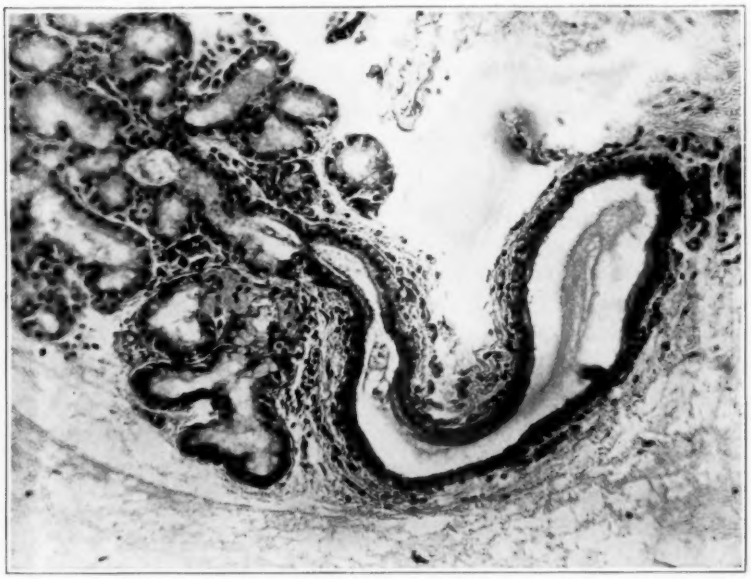

Fig. 1.—The collecting ampullary duct from a mucous gland of the esophagus. Hematoxylin and eosin; × 140.

a thin stratified lining continuous with the superficial stratified squamous epithelium. Flesh [8] (1888) noted that the duct in the lamina propria mucosae is frequently surrounded by accumulations of leukocytes. More often they are lymphocytes and form a true nodule with a germinal center. The protoplasm of the secretory cells of those glands stains deeply with mucin stains and pale blue with hematoxylin and eosin stain and is practically unstained by the Van Gieson stain. The nuclei are flattened against the bases, and the cytoplasm contains no structures

8. Flesh, M.: Ueber Beziehungen zwischen Lymphfollikeln und secretierenden Drüsen im Oesophagus, Anat. Anz. **2**:283, 1888.

except numerous coarse vacuoles, as revealed by mucin stains. When the duct is blocked the gland becomes, at times, markedly dilated (fig. 3).

The superficial, or cardiac, glands are the same as the glands of the cardia of the stomach. They are located in the lower end of the esophagus, extending a few millimeters above the cardia. Here they occur as either blind ducts or opening directly into the lumen, but always superficial to the muscularis mucosae. In the upper end, at about the level of the cricoid cartilage, the esophageal mucous membrane presents two lozenge-shaped depressions, one on either side of the lateral wall, as far down as the fifth tracheal ring. The diameter varies from 1 cm.

Fig. 2.—The opening of the duct of an esophageal gland into the lumen of the esophagus. This demonstrates the vulnerability of these structures to infection from within. Hematoxylin and eosin; × 130.

to a microscopic dimension. These areas mark the site of the superficial glands of the upper part of the esophagus.

According to Nicholson[9] (1923), the superficial glands are present in 75 per cent of all persons. Taylor[10] (1927) reported finding in a series of 900 postmortem examinations performed at the Leeds General Infirmary 6 cases in which these areas appeared in the upper part of

9. Nicholson, G. W.: Heteromorphoses (Metaplasia) of the Alimentary Tract, J. Path. & Bact. **26**:399, 1923.

10. Taylor, A. L.: The Epithelial Heterotopias of the Alimentary Tract, J. Path. & Bact. **30**:415, 1927.

the esophagus. They varied in longitudinal measurement from 1/8 to 3/4 inch (about 3 mm. to 2 cm.). They are usually irregular and have a smooth, pink or reddish surface which is slightly depressed below the level of the esophageal epithelium. The margins are somewhat raised and present a whitish, sodden appearance. They simulate small erosions or shallow ulcers, are usually bilateral and most often are located on the posterior wall. Taylor expressed the belief that they are heterotopic patches of gastric mucous membrane. Ireland [11] (1933), on the contrary, stated, "I do not believe that true gastric mucosa is ever present in the esophagus."

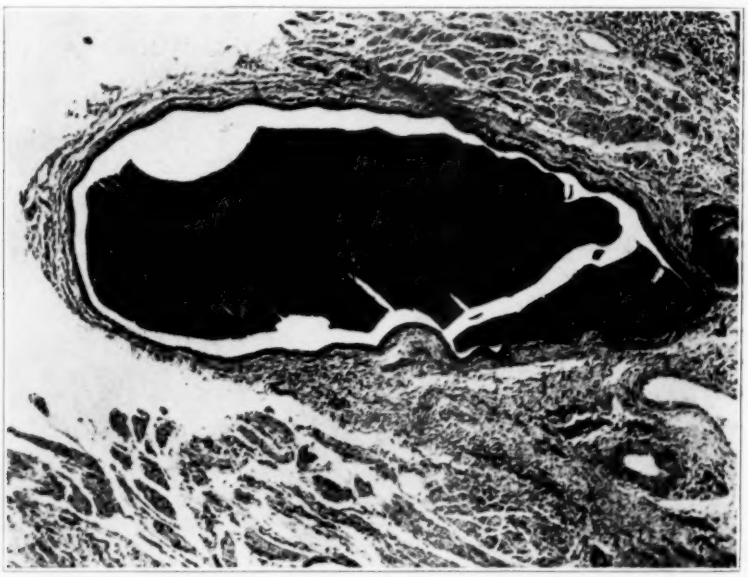

Fig. 3.—A dilated duct of a deep esophageal gland filled with mucus. Mucin stain; × 50.

The cardiac glands are short, branched, tubular glands. The cells which compose these glands are not flattened and have basal nuclei. Schumacher [12] (1927) said that there are parietal cells in these glands. Ireland stated that they may or may not be present. Most writers, however, have been certain that they are not present. Cells of the cardiac glands stain pale gray with hematoxylin and eosin, the gray of serous cells with the Van Gieson stain and very lightly with mucin

11. Ireland, P. E.: Glands of the Esophagus, Laryngoscope **43**:351 (May) 1933.

12. Schumacher, E.: Handbuch der mikroskopischen Anatomie des Menschen, Berlin, Julius Springer, 1927, p. 301.

stains. The ducts are lined with columnar epithelial cells and open into the lumen of the esophagus. A number of the ducts end blindly.

The details of the blood supply of the esophagus were demonstrated by Demel [13] (1924). He carried out injection experiments on the esophagus and from these concluded that the blood supply varies in different parts. The cervical portion is richly supplied by the inferior thyroid artery and an inconstant branch from the subclavian artery. The area beneath the tracheal bifurcation is best supplied with blood; it receives branches from the anterior and posterior esophagotracheal arteries. The thoracic, or middle, third of the esophagus is poorly supplied, especially the right and anterior walls of the upper part of this third. The supply of the right wall of the lower part of the middle third is even poorer and comes from a varying number of aortic and intercostal branches. The abdominal portion on the right side is well supplied by the left gastric artery. The inferior phrenic artery, in most cases, supplies the left and the posterior wall. There is also a rich anastomosis on the right side between the arteries of the pars abdominalis and those of the pars thoracalis. Nevertheless, the blood supply in general of the thoracic portion greatly exceeds that of the abdominal portion.

The veins of the esophagus, according to Kaufmann and Reimann [14] (1929), form a submucous and periesophageal plexus. Those of the lower portion drain into the azygos and intercostal veins; those of the upper portion, by way of the inferior thyroid vein into the superior vena cava.

The importance of the venous plexus of the esophagus was considered in detail by Kegaries [15] (1934). He pointed out (but he was not the first to do so) that because the normal submucosal veins of the esophagus often assume sinus-like dimensions (fig. 4) they form a highly vulnerable structure and that hemorrhage may occur in conditions such as cardiac decompensation, portal obstruction, disease of the spleen, trauma and ulceration of the esophagus.

The lymphatic structures, according to Jackson [16] (1914), form separate plexuses in the mucosa and submucosa. The collecting vessels are divided into three sets. The upper set drains to the deep cervical

13. Demel, Rudolf: Die Gefässversorgung der Speiseröhre; ein Beitrag zur Oesophagus-Chirurgie, Arch. f. klin. Chir. **128**:453, 1924.

14. Kaufmann, Edward, and Reimann, S. P.: Pathology for Students and Practitioners, Philadelphia, P. Blakiston's Son & Co., 1929, vol. 1, p. 629.

15. Kegaries, D. L.: The Venous Plexus of the Oesophagus: Its Clinical Significance, Surg., Gynec. & Obst. **58**:46 (Jan.) 1934.

16. Jackson, C. M.: Morris' Human Anatomy, Philadelphia, P. Blakiston's Son & Co., 1914, pp. 728, 954, 1037 and 1138.

chain, those of the thoracic portion pass to the bronchial and posterior mediastinal nodes and those of the lower portion empty into the superior gastric nodes.

The nerves form two sympathetic plexuses, the submucous (Meissner's) plexus and the myenteric (Auerbach's) plexus, from which the walls are supplied. The right vagus nerve joins with branches of the left to form the posterior esophageal plexus. The left vagus nerve joins with branches of the right vagus nerve to form the anterior esophageal plexus. Branches of the right and left recurrent laryngeal nerves also give branches to the esophagus. The sympathetic supply

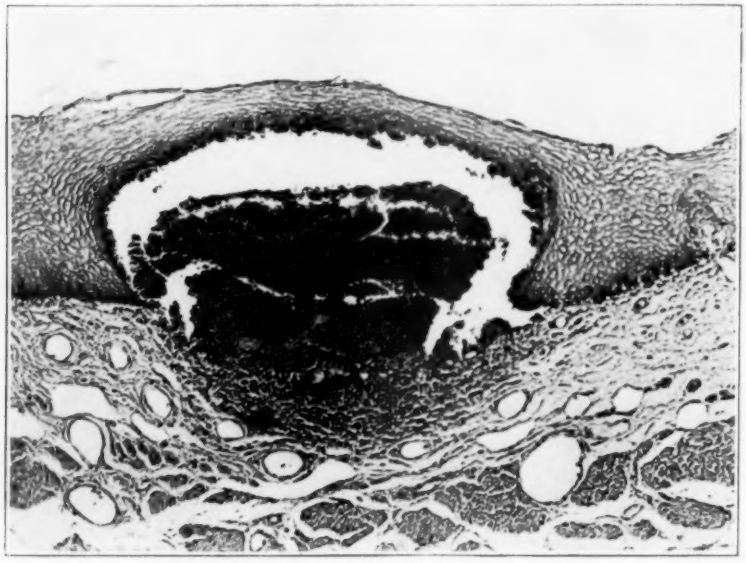

Fig. 4.—A large varix in the epithelium of the esophagus. This illustrates the ease with which hemorrhage could occur if this area were ulcerated. Hematoxylin and eosin; × 50.

arises from the peripheral upper branches of the upper four or five ganglions, and these branches join the anterior and posterior esophageal plexuses.

POSTMORTEM DIGESTION OF THE ESOPHAGUS

As early as 1786 John Hunter [17] published his observations on self-digestion of the esophagus, stating that it is a postmortem process. Carswell [18] in 1838 and Elsaesser [19] in 1846 said that it is attributable

17. Hunter, John: The Works of John Hunter, F. R. S., with Notes, London, Longman, Reese, Orme, Brown, Green and Longman, 1835, vol. 2.

18. Carswell, Robert, quoted by Canton.[22]

19. Elsaesser, C. L., quoted by Cushing.[74]

to the action of the gastric juice after death. King [20] in 1842 reported one case each of typhus fever, injury to the brain and peritonitis in which esophageal softening appeared. He concluded that it is caused by the action of regurgitated gastric juice after death. Trotter [21] (1850) reported on a patient who had been troubled with nausea and vomiting for three weeks; at examination, following a rather sudden death, a perforating ulcer of the esophagus was discovered. Others also have noticed the frequency of digestion of the esophagus associated with a history of vomiting. Canton [22] (1859) and Moxon [23] (1870) reported cases similar to Trotter's case. They stressed the rarity of postmortem solution of the esophagus. Smith [24] (1865) said that children from 3 to 4 months of age frequently die of "so-called" esophagitis. A definite relationship between esophagomalacia and rupture of the esophagus was clearly pointed out by Fitz [25] in 1877. In 1878 Zenker and von Ziemssen [26] gave a complete review of the subject of esophagomalacia. They concluded that the softening does not always occur after death but that it probably begins in the agonal stage and advances, sometimes even to perforation. Sir Morell Mackenzie [27] (1884) questioned the fact that softening takes place after death. If it does occur, he wrote: "The chief factors are: 1. presence in the channel for a considerable time of gastric juice which retains its normal acidity; 2. a proper degree of temperature, 90 to 100° F.; 3. loss of resistance in the tissue to digestive power of the fluids." He expressed the opinion that it is more common in young children than in older children and adults and that it never extends above the lower half of the esophagus.

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20. King, T. W.: Observations on the Digestive Solution of the Oesophagus, and on the Distinct Properties of the Two Ends of the Stomach, Guy's Hosp. Rep. **7**:139, 1842.

21. Trotter, J. W.: Ulceration of the Oesophagus Perforating the Pericardium, Tr. Path. Soc. London **3**:316, 1850-1852.

22. Canton, Edwin: Case of Digestive Solution of the Oesophagus, Lancet **2**:362 (Oct. 8) 1859.

23. Moxon, W.: Post-Mortem Solution of the Oesophagus and Not of the Stomach, Tr. Path. Soc. London **21**:159, 1870.

24. Smith, Lewis: Inflammation of the Esophagus in an Infant, New York M. J. **2**:373, 1865.

25. Fitz, R. H.: Rupture of the Healthy Oesophagus, Am. J. M. Sc. **73**:17 (Jan.) 1877.

26. Zenker, F. A., and von Ziemssen, H. W.: Diseases of the Oesophagus, in von Ziemssen: Cyclopedia of the Practice of Medicine, New York, William Wood & Company, 1878, vol. 8, p. 1.

27. Mackenzie, Morell: Diseases of the Throat and Nose Including the Pharynx, Larynx, Trachea, Oesophagus, Nose, and Naso-Pharynx, Philadelphia, P. Blakiston's Son & Co., 1884, vol. 2, p. 321.

Most modern textbooks tend to dismiss the subject of esophagomalacia with a few words. It is generally accepted that most tissues, according to MacCallum [28] (1927), can liberate in varying degrees the proteolytic ferment necessary to dissolve their own cell bodies. Morse [29] (1916) observed that a slightly acid reaction accelerates the autolytic process. Dernby [30] (1918), in studying the autolytic process in the stomach, liver and pancreas, observed that autolysis proceeds more rapidly if the reaction is first slightly acid and then alkaline. Bell [31] (1930) has frequently observed postmortem perforation of the lower part of the esophagus, whereas Cleland [32] (1934) has noted only 2 cases of postmortem digestion of the esophagus in 3,000 consecutive postmortem examinations.

It may be concluded, however, that postmortem digestion of the esophagus is a distinct entity. The factors producing this condition are probably regurgitation of gastric juices following death, the heat of the body and perhaps other unknown factors.

PEPTIC ULCER OF THE ESOPHAGUS

Albers [33] (1883) reported the first case of "peptic ulcer of the esophagus." Quincke [34] (1879) proved the diagnosis in 3 cases by histologic examination and placed the condition on a definite clinical and pathologic basis. He suggested also that the vomiting of blood is an important diagnostic observation. These ulcers had been considered by Zenker and von Ziemssen (1878) as the result of the digestive action of the gastric content on the esophagus. It was Fraenkel [35] (1899), however, who first observed the presence of islands of supposedly heterotopic gastric mucous membrane in the upper third of the esophagus in a case of peptic ulcer of the lower third of the esophagus. This observation naturally brought forth a great amount of speculation

28. MacCallum, N. G.: A Textbook of Pathology, Philadelphia, W. B. Saunders Company, 1927, p. 60.

29. Morse, Max: Is Autolysis an Autocatalytic Phenomenon? J. Biol. Chem. **24**:163, 1916.

30. Dernby, K. G.: A Study on Autolysis of Animal Tissues, J. Biol. Chem. **35**:179 (Aug.) 1918.

31. Bell, E. T.: A Textbook of Pathology, Philadelphia, Lea & Febiger, 1930.

32. Cleland, J. B.: Pathological Lesions Met with in the Oesophagus During Post Mortem Examinations, M. J. Australia **1**:588 (May 5) 1934.

33. Albers, quoted by Tileston.[36]

34. Quincke, H.: Ulcus oesophagi ex digestione, Deutsches Arch. f. klin. Med. **24**:72, 1879.

35. Fraenkel, Alexander: Ueber die nach Verdauungsgeschwüren der Speiseröhre entstehenden narbigen Verengerungen, Wien. klin. Wchnschr. **12**:1039 (Oct. 19) 1899.

as to the probable etiology of this lesion. Tileston [36] (1906) and Stewart and Hartfall [37] (1929) confirmed Fraenkel's observation. Sheehan [38] (1934) and Stewart and Hartfall (1929) were convinced that the ectopic gastric mucosa which they observed, with abundant oxyntic cells, would secrete acid gastric juice. The Jacksons [39] (1934) suggested that the presence of islands of gastric mucosa in the esophagus is probably a factor in the etiology of peptic ulcer but not necessarily an essential one. Hurst [40] (1934) also expressed the belief that these heterotopic islands secrete acid, which possibly collects in the lower part of the esophagus and accounts for the frequent occurrence of the lesion just above the cardia. Taylor [10] (1927) expressed the belief that, even if these islands do secrete acid gastric juice, such a secretion must be constantly neutralized by the swallowed saliva. He said that it is unlikely that these areas cause damage to the epithelium and that he had never observed any inflammatory reaction in relation to these aberrant glands. Ireland [11] (1933) maintained that true gastric mucosa is never present in the esophagus, and Lendrum [41] (1934) confirmed his views.

In Tileston's [36] (1906) collection from the literature of the reports of 40 cases of peptic ulcer of the esophagus, 28 were in males and 12 in females. In the 62 cases reported by Cantieri [42] (1910), two thirds of the patients were males and 90 per cent were aged 50 years or more. In 6 cases of his own Tileston observed hemorrhage from the ulcer in 53 per cent and perforation in 14 per cent. In 81 per cent of the cases only one ulcer was present.

Usually the lesions are described as being in the lower third of the esophagus. They rarely extend down into the stomach. Their diameters vary from a few millimeters to a centimeter. Usually they are single, but they may be multiple. Sometimes they appear as only hemorrhagic erosions or simple mucosal ulcers. Occasionally they may be very deep, and blood vessels may become eroded, leading to hemorrhage

36. Tileston, Wilder: Peptic Ulcer of the Oesophagus, Am. J. M. Sc. **132**: 240 (Aug.) 1906.

37. Stewart, M. J., and Hartfall, S. J.: Chronic Peptic Ulcer of the Oesophagus, J. Path. & Bact. **32**:9, 1929.

38. Sheehan, D.: The Effect of Cortical Stimulation on Gastric Movements in the Monkey, J. Physiol. **83**:177 (Dec. 31) 1934.

39. Jackson, C., and Jackson, C. L.: Pulmonary Symptoms Due to Esophageal Disease, Arch. Otolaryng. **18**:731 (Dec.) 1934.

40. Hurst, A. F.: Chronic Peptic Ulcer of the Oesophagus, Guy's Hosp. Rep. **84**:104 (Jan.) 1934; Some Disorders of the Esophagus, J. A. M. A. **102**:582 (Feb. 24) 1934.

41. Lendrum, F. C.: The Anatomical Feature of the Cardiac Orifice of the Stomach, Thesis, University of Minnesota, 1934.

42. Cantieri, quoted by Bartels.[72]

or perforation. Grossly and microscopically the lesion resembles a simple ulcer of the stomach. The usual appearance is that of chronic inflammatory tissue.

Pain, dysphagia, vomiting, hemorrhage and perforation are the most prominent symptoms. After Fraenkel's (1899) observation concerning the association of gastric heterotopic tissue with this condition, most writers considered this factor the etiologic agent. It is interesting to note that all these areas of so-called gastric heterotopic tissue appeared in the exact situation where normally are the upper esophageal cardiac glands. As Ireland [11] (1933) pointed out, no acid-secreting cells were shown by any of these authors in their photomicrographs of these areas. He assumed, as did Lendrum [41] (1934), and we are inclined to agree, that these areas, previously reported by other writers as islands of heterotopic gastric mucosa, are in reality only areas of normal cardiac esophageal glands.

Many writers at present use the term "peptic ulcer of the esophagus" to signify almost any type of esophageal ulceration. This particular phase of the subject will be discussed in the second paper in this group of two papers. It seems reasonable to us that these areas of so-called peptic ulcer are probably small erosions initiated by some factor or factors and gradually aggravated, possibly by regurgitated gastric juice, until they assume a size sufficient to evoke clinical symptoms. In other words, the authors who have written on "peptic ulcer of the esophagus" were dealing with persistent acute ulcerative esophagitis.

ETIOLOGY OF ESOPHAGITIS

Effect of Gastric Juice.—Regurgitation and Physiology: As Bell [31] (1930) pointed out, postmortem perforation of the esophagus occurs frequently as a result of backflow of gastric juice after death. Relaxation of the cardiac orifice probably occurs in some cases soon after death or in the few terminal hours before death, thus allowing backflow of the gastric content. However, at the postmortem table the orifice is often observed to be closed. That regurgitation during life contributes to the production of esophagitis is still debated.

In order to discuss intelligently the subject of regurgitation, it becomes necessary to consider the physiology of the esophagus. It is not within the scope of this paper to discuss the numerous theories concerning the anatomic nature of the cardiac orifice. Mosher [43] (1930) observed a definite cardiac sphincter, often present at birth. Lendrum [41] (1934), however, concluded that in the human being there is no morpho-

43. Mosher, H. P.: The Lower End of the Oesophagus at Birth and in the Adult, J. Laryng. & Otol. **45**:161 (March) 1930.

logic evidence of a sphincter muscle at the cardia. Huntington [44] expressed the belief that the weakness of the cardiac sphincter of man is an inheritance from lower forms of life in which there is but little division between the cavities of the esophagus and stomach.

The normal esophagus generally contains some air, and according to Alvarez [45] (1928) it may be seen to dilate a little with each inspiration. Bennett [46] (1925) stated that the upper and lower ends of the esophagus are normally closed by the sphincteric action of circular muscle fibers and that the portion of the tube between these limits is normally held open by the negative pressure within the thorax.

According to Howell [47] (1922), food, solid or semisolid, is forced down the esophagus by a peristaltic movement of the musculature. From above downward the circular muscles are constricted by an advancing muscular wave. The same movements occur in the swallowing of liquid or soft food, but in such cases the peristaltic wave follows the actual descent of the food. The entire act of swallowing is essentially a reflex act. As far as the esophagus is concerned, the motor fibers are from the vagus nerves, and in normal swallowing these are excited reflexly from the pharynx at the beginning of the act.

Cannon [48] (1898) observed in the cat, by the use of roentgen rays, a rhythmic regurgitation from the stomach into the esophagus. The mixture of barium was often seen to run to the level of the heart and sometimes even into the throat, and then back again. This appeared to be attributable to rapid contractions of the lower part of the esophagus. No reverse peristalsis could be seen. Cannon further observed that he could stop this process by acidulating the gastric content. From that he concluded that the cardia must be controlled by acidity, just as, he thought, was the pylorus. Carlson and Luckhardt [49] (1914) failed to confirm all of Cannon's results. They observed, in addition

44. Huntington, G. S.: The Anatomy of the Human Peritoneum and Abdominal Cavity Considered from the Standpoint of Development and Comparative Anatomy, Philadelphia, Lea Brothers & Co., 1903.

45. Alvarez, W. C.: The Mechanics of the Digestive Tract: An Introduction to Gastroenterology, New York, Paul B. Hoeber, Inc., 1928, pp. 87, 288, 295 and 333.

46. Bennett, T. I.: The Stomach and Upper Alimentary Canal in Health and Disease, London, William Heinemann, Ltd., 1925, p. 65.

47. Howell, W. H.: A Textbook of Physiology for Medical Students and Physicians, Philadelphia, W. B. Saunders Company, 1922, p. 711.

48. Cannon, W. B.: The Movements of the Stomach Studied by Means of the Roentgen Rays, Am. J. Physiol. **1**:359, 1898.

49. Carlson, A. J., and Luckhardt, A. B.: Contributions to the Physiology of the Stomach: X. The Condition of the Oesophagus During the Periods of Gastric Hunger Contractions, Am. J. Physiol. **33**:126, 1914; Studies on the Visceral Sensory Nervous System: X. The Vagus Control of the Oesophagus, ibid. **57**:299, 1921.

to the peristaltic waves produced by swallowing, that the esophagus possesses two other types of movement. If the esophagus of a man was distended with a balloon there usually appeared a series of rapid, continuous contractions. At times these were regular in rate and amplitude. They were, apparently, local contractions: they did not move the distended balloon, and they were not under conscious control. Carlson and Luckhardt (1921) also observed that the esophagus may give evidence of tonic contractions. If these were prolonged they were felt as a fulness in the thorax or throat. These contractions could be produced by the local mechanical stimulation of the distended balloon.

Relaxation of the cardia occurs with each esophageal peristaltic wave. Carlson, Boyd and Pearcy [50] (1922) found that in unanesthetized dogs the tone of the cardiac sphincter can be temporarily inhibited by stimulation of the mucous membrane of the stomach and even more so by stimulation of the sensory nerves in the mouth and pharynx. They observed that the tone increases during the process of digestion and also when the walls of the stomach are suddenly distended. In the normal animal Evans and Hartridge [51] (1933) observed that stimulation of the peripheral end of the vagus nerve causes strong contractions of the cardiac sphincter and esophagus. Section of the vagal trunks produces, according to Wright [52] (1934), complete paralysis of the striated part of the esophagus. Section of the vagus nerves in the neck results in temporary spasm of the cardia. This, however, is transient and is soon replaced by marked relaxation of the sphincter. By strong stimulation of the sensory nerves from the abdominal viscera spasm of the cardia is reflexly produced through the sympathetic nerves. The sympathetic nerves, however, according to May [53] (1904) and Jurica [54] (1926), have little effect on the movement of the esophagus. Passage of the peristaltic waves in the esophagus depends on the continuity of the nerve plexus and not on the integrity of the muscular coat.

Wright maintained that reversed peristalsis may occur in the esophagus and that it is responsible, in part, for belching and regurgitation of acid material into the pharynx. Alvarez [45] (1928) observed that

50. Carlson, A. J.; Boyd, T. E., and Pearcy, J. F.: Studies on the Visceral Sensory Nervous System: XIV. The Reflex Control of the Cardia and Lower Esophagus in Mammals, Arch. Int. Med. **30**:409 (Oct.) 1922.

51. Evans, C. L., and Hartridge, H.: Starling's Principles of Human Physiology, Philadelphia, Lea & Febiger, 1933, p. 572.

52. Wright, Samson: Applied Physiology, ed. 5, New York, Oxford University Press, 1934, p. 491.

53. May, W. P.: The Innervation of the Sphincters and Musculature of the Stomach, J. Physiol. **31**:260, 1904.

54. Jurica, E. J.: Studies on the Motility of Denervated Mammalian Esophagus, Am. J. Physiol. **77**:371 (July) 1926.

reverse peristalsis in the esophagus of man has never been observed except in the presence of disease. He wrote that it is attributable not to peristalsis but to powerful contractions at the lower end of the esophagus. Alvarez said that ripples of reverse peristalsis running up the esophagus are probably of common occurrence, especially in persons who suffer from indigestion.

Frequently in roentgenoscopic examinations one sees the mixture of barium shooting up the esophagus, even as far as the mouth. We are informed by the roentgenologists at the Mayo Clinic that this phenomenon is likely to occur with the patient in either a prone or an upright position and that its frequency does not depend on the patient's position. It is apparently an unconscious act. The work of Robins and Jankelson [55] (1926) showed that the gastric juice has ready access to the esophagus. In a series of 103 cases, which represented 4.6 per cent of their cases studied, they noted cardio-esophageal relaxation, as evidenced by the reflex of barium from the stomach into the esophagus without hindrance by closure of the lower end of the esophagus.

Most observers agree with Cannon [56] (1902), Crohn [57] (1927) and Evans and Hartridge [51] (1933) that during digestion there is a rhythmic alternation of contraction and relaxation, producing a periodic lessening of the contraction tonus of the cardia. This allows regular regurgitation of a small quantity of gastric content into the lower part of the esophagus as far as the level of the heart. This regurgitation is at once followed by a peristaltic wave which drives the escaped material back into the stomach. Crohn (1927) claimed that this phenomenon is observed only soon after a meal and requires fluidity of gastric chyme for its occurrence. He expressed the belief that this regurgitation takes place only when the organ is full and under increased pressure. It has been supposed that movements of regurgitation become more and more infrequent as the gastric content becomes acid. Finally, sufficient free acid is produced and atonic closure of the esophagus occurs, putting an end to the retrograde flow of chyme. Nevertheless, according to Evans and Hartridge (1933), the modern view associates the increasing tone of the lower end of the esophagus with distention of the stomach and the stage of digestion.

To summarize this much debated subject of esophageal physiology, it appears that the strongest evidence favors the theory that, in at least a

55. Robins, S. A., and Jankelson, I. R.: Cardio-Esophageal Relaxation, J. A. M. A. **87**:1961 (Dec. 11) 1926.

56. Cannon, W. B.: The Movements of the Intestines Studied by Means of the Roentgen Rays, Am. J. Physiol. **6**:250, 1902.

57. Crohn, B. E.: Affections of the Stomach, Philadelphia, W. B. Saunders Company, 1927, p. 96.

high percentage of cases, regurgitation of gastric content into the esophagus is a normal process.

In regard to the action of gastric juice on the esophagus, Pavy [58] (1869) suggested that the layer of mucus that is present protects the membrane from the action of its own juices and that the normally alkaline blood circulating in the wall counteracts the action of the acid of the mucosal secretion. In 1914 Smith [59] produced hemorrhagic ulcerations in the stomach of fasting dogs by injecting a mixture of bile and 0.5 per cent hydrochloric acid into the mucous membrane. The hydrochloric acid alone would not produce ulcers. The presence of mucus would protect the gastric epithelium. Before each experiment he was required to free the epithelium of mucus, or else his results would be negative. The fact that the esophageal mucous membrane is nearly always covered by its own special mucoid secretion was recently shown by Vineberg and Komarov [60] (1933). These workers noted that in dogs the secretions of the esophageal glands are controlled by the vagus nerves. By stimulating the vagus nerves and collecting the secretion through separate cannulas Vineberg and Komarov were able to observe that the upper half of the esophagus always secretes more mucus. From a detailed chemical analysis of the collected specimens they concluded that the esophageal secretion is special and differs from the other secretions of the alimentary canal. The esophageal mucus gives no evidence of having enzymic powers. Working on the problem of the absorptive power of the esophagus, Webb, Mullenix and Dragstedt [61] (1932) were able to show that the greatest mechanical barrier to absorption in the esophagus is mucus. Hilding [62] (1932) showed that there is an unbroken protective layer of mucus overlying the nasal mucous membranes. This, he observed, is continuous with that of the pharynx and esophagus. This mucous coat obviously protects at all times the membrane lining the esophagus. However, if it is removed or altered or if a

58. Pavy, F. W.: A Treatise on the Function of Digestion: Its Disorders, and Their Treatment, Philadelphia, N. E. Lea, 1869.

59. Smith, G. M.: An Experimental Study of the Relation of Bile to Ulceration of the Mucous Membrane of the Stomach, J. M. Research **30**:147 (May) 1914.

60. Vineberg, A. M., and Komarov, S. A.: The Influence of the Vagus Nerve on Esophageal Secretion, Am. J. Physiol. **104**:73, 1933.

61. Webb, W. W.; Mullenix, R. B., and Dragstedt, C. A.: Absorption of Drugs from the Esophagus, Proc. Soc. Exper. Biol. & Med. **29**:895 (April) 1932.

62. Hilding, Anderson: The Physiology of Drainage of Nasal Mucus: I. The Flow of the Mucus Currents Through the Drainage System of the Nasal Mucus and Its Relation to Ciliary Activity, Arch. Otolaryng. **15**:92 (Jan.) 1932; II. Cilia and Mucin in the Mechanical Defense of the Nasal Mucosa: A Motion Picture Demonstration, Ann. Otol., Rhin. & Laryng. **41**:52 (March) 1932.

break occurs in the epithelium, then there is offered a condition in which harmful substances can affect the mucous membrane.

Friedenwald, Feldman and Zinn [63] (1928) produced small lesions in the esophagus of the dog through an esophagoscope and observed that they healed rapidly. The investigators could prevent rapid healing of the erosion, or mucosal type of ulcer, by the use of hydrochloric acid. The deep ulcers, produced by taking deep bites of tissue, could be made to perforate, or their healing could be markedly retarded, by the continuous use of hydrochloric acid. A persistent sign of all the active ulcers was bleeding. There was observed also a marked increase in the secretion of mucus by the deep esophageal glands.

So, from the evidence presented it appears that the esophageal mucosa is a well protected membrane. Apparently it is only when, for some reason, an inadequate amount of mucus is present or when an erosion is present that the regurgitated gastric juices play an important part in the production of esophagitis. Brush [64] (1883) well stated:

> It seems untenable that ruptures of the esophagus are due to postmortem digestion, when we recollect that these children in whom ruptures take place are in a feeble condition and the evidence that the peptonic action of the stomach is suspended is proved by the unchanged condition of the food which is returned from the stomach. We can hardly suppose that a stomach that will not coagulate milk would have the power to digest an esophagus. There is no reason why the esophageal tract should not be subject to a special disease as it is a distinct structure.

The Rôle of Vomiting.—It has been noted by a large group of observers that esophagitis commonly accompanies diseases in which there are frequent attacks of vomiting. Whether or not the act of vomiting, in itself, is a factor in the production of this condition should be considered. It is not our intention to review the literature on this subject. We shall try, however, to give some of the more commonly accepted views.

Mellinger [65] (1881) observed the exposed esophagus of the dog during vomiting and saw no reverse peristalsis. He did observe, however, that when the gastric content was forced into the esophagus the latter dilated and contracted, giving the appearance of a bladder filling and emptying. Part of the content was forced out through the mouth, and with the help of peristaltic waves a little was returned to the stomach. Mellinger concluded that the esophagus is not essential to the

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63. Friedenwald, Julius; Feldman, Maurice, and Zinn, W. F.: Ulceration of the Esophagus: Experimental Study, Arch. Int. Med. **42**:521 (Oct.) 1928; Peptic Ulcer of the Esophagus, Tr. Am. Gastro-Enterol. A. **31**:93, 1929.

64. Brush, E. F.: Oesophagitis as a Disease of Infancy, M. Rec. **23**:35 (Jan. 13) 1883.

65. Mellinger, C., quoted by Alvarez.[45]

act of vomiting, because animals continue to vomit normally even after the esophagus has been replaced by a glass tube.

Mann [66] (1928) observed that dogs from which he had removed the entire stomach vomited normally if given coarse food. Rost [67] (1923) observed that men and women vomit even after total gastrectomy. Cannon [48] (1898) noted that the stomach plays a relatively passive rôle in ridding itself of irritants.

According to Hatcher [68] (1924), the more primitive creatures vomit with the help of the gastric and esophageal muscles only. Among higher animals many different mechanisms are operative, and the voluntary and involuntary elements are combined in different degrees. Most observers have agreed that the abdominal muscles must contract powerfully if the stomach is to be emptied. Smead [69] (1931) observed that rupture of the esophagus may follow severe vomiting, but only when the stomach is full. Hesse [70] took serial roentgenograms of the esophagus during vomiting and observed that the cardiac orifice remained open and that the food was carried back and forth through the esophagus several times during the act of retching. Occasionally, most of it was returned to the stomach. Alvarez [45] (1928) noticed that vomiting by cats is sometimes preceded by reverse peristalsis in the bowel. The fact that human beings sometimes vomit large quantities of fluid after the stomach has been well washed out suggested to him that the fluid probably comes from the lower part of the bowel.

Gold and Hatcher [71] (1926) showed that the one part of the brain of the cat that is essential to vomiting consists of the sensory nuclei of the vagus nerves. This is probably the "vomiting center."

Bartels [72] (1932) reported 82 cases of acute ulceration of the esophagus. These cases represented 0.013 per cent of the total of 6,000 reports of necropsy that were examined. The condition occurred more frequently in the presence of sepsis or infection, but in 72 per cent of his 82 cases vomiting had occurred. Bartels maintained that gastric juice is the main etiologic factor in the production of esophagitis.

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66. Mann, F. C., quoted by Alvarez.[45]

67. Rost, Franz: The Pathological Physiology of Surgical Diseases: A Basis for Diagnosis and Treatment of Surgical Affections, Philadelphia, P. Blakiston's Son & Co., 1923, p. 67.

68. Hatcher, R. A.: The Mechanism of Vomiting, Physiol. Rev. **4**:479 (July) 1924.

69. Smead, L. F.: Spontaneous Rupture of the Esophagus Following Vomiting, Am. J. Surg. **13**:497 (Sept.) 1931.

70. Hesse, O., quoted by Alvarez.[45]

71. Gold, Harry, and Hatcher, R. A.: Studies on Vomiting, J. Pharmacol. & Exper. Therap. **28**:209, 1926.

72. Bartels, E. C.: Acute Ulcerative Esophagus, Thesis, University of Minnesota, 1932.

It appears, then, that the esophagus in the act of vomiting plays a passive rôle. No doubt the esophagus is often dilated somewhat rapidly, and excessive movement occurs in an effort to rid itself of the material in its lumen. The frequent bathing of the mucous membrane by the gastric content probably has something to do with the production of esophagitis. Of course the mechanical factors of stretching, with possible small breaks in the mucous membrane, and the increased peristalsis all lend themselves to producing congestion and erosion.

That vomiting alone can produce these lesions has been shown in cases of stricture following the vomiting of pregnancy. The results to be reported in the second paper of this group of two papers and the results of Bartels show that vomiting is the most important factor in the production of esophagitis.

Neurogenic Origin.—Rokitansky [73] (1849), according to Cushing [74] (1932), was the first to make a definite suggestion that perforation and ulceration of the esophagus may have a neurogenic origin. He observed acute gelatinous softening of the stomach in the newly born, frequently associated with a demonstrable intracranial lesion. The cause, he suggested, was probably the diseased innervation of the stomach and the acid gastric juice. King [20] (1842) reported a case of ulceration of the esophagus associated with injury of the brain. Hoffmann [75] (1868) described a case of esophageal perforation associated with a tumor in the right half of the pons and medulla. Arndt [76] (1888) described a similar case in which there was a tumor of the cerebellum, and Howse [77] (1884) reported a case of rupture of the esophagus associated with a fractured skull.

As early as 1867 Schiff [78] produced gastric movements comparable to those elicited by vagal stimulation by stimulating the corpora quadrigemina, the cerebral peduncles, the pons and the cerebellar peduncles. He could block these movements by division of the vagus nerves. In stimulation of the splanchnic nerves he noted contraction of the vessels of the stomach. Ebstein [79] (1874) was able to form small

73. Rokitansky, Carl: A Manual of Pathological Anatomy, translated from the German by E. Sieveking, London, Sydenham Society, 1849, vol. 2.

74. Cushing, Harvey: Peptic Ulcers and the Interbrain, Surg., Gynec. & Obst. **55**:1 (July) 1932.

75. Hoffmann, C. E. E.: Ueber die Erweichung und den Durchbruch der Speiseröhre und des Magens, Virchows Arch. f. path. Anat. **40**:352, 1868.

76. Arndt, Rudolf: Neubildung im Gehirn, Magenerweichung und einfaches oder rundes Magengeschwür, Deutsche med. Wchnschr. **14**:83 (Feb. 2) 1888.

77. Howse: Case of Rupture of the Esophagus: Fractured Base; Necropsy, Lancet **1**:112 (Jan. 19) 1884.

78. Schiff, M., quoted by Cushing.[74]

79. Ebstein, Wilhelm: Experimentelle Untersuchungen über das Zustandekommen von Blutextravasaten in der Magenschleimhaut, Arch. f. exper. Path. u. Pharmakol. **2**:183 (April 17) 1874.

admitted during September and a like number in October. In November quadrigemina by injecting chromium trioxide. In 9 of 23 animals he was able to produce ulcerative lesions in the stomach. Welch [80] (1885), nevertheless, considered the theory that gastric ulcers are of neurogenic origin as altogether speculative. Brosch [81] (1900) advanced a diametrically opposite opinion and concluded that the softening is seen experimentally only when injury or disease of the brain is present. He stated: "In Ziemssen's cases from the Pathological Institute at Eilangen, eight of the nine were associated with a brain lesion. In the ninth the brain was not examined." Von Winiwarter [82] (1911) and Meyer [83] (1912) pointed out that the ulcerative lesions most consistently produced in the laboratory had been either paralytic on the part of the sympathetic nerves or stimulatory on the part of the vagus nerves. Rössle [84] (1913) suggested also that the vagal action was possibly produced by reflex stimulation from a region of primary disease elsewhere. Korst [85] (1928) also reported cases of cerebellar tumor, hydrocephalus and tumor compressing the vagal nucleus which resulted in gastric erosion or fatal hemorrhage. Durante [86] (1916) also produced congestion and ulceration of the stomach and upper part of the duodenum associated with hemorrhage into the adrenal gland on the affected side by section of the median splanchnic nerves. He concluded that the irritation of the nerves running to the adrenal medulla resulted in an outpouring of epinephrine, subsequent constriction of the vessels to the intestinal mucosa, hemorrhage and ulceration. Light, Bishop and Kendall [87] (1932) agreed with Durante's conclusions that the acid gastric juice acting on the mucosa, with the lessened resistance attributable to constricted blood

80. Welch, W. A.: Simple Ulcer of the Stomach, in Pepper, William: A System of Practical Medicine by American Authors, Philadelphia, Lea Brothers & Co., 1885, p. 480.

81. Brosch, Anton: Die spontane Ruptur der Speiseröhre auf Grund neuer Untersuchungen, Virchows Arch. f. path. Anat. **162**:114 (Oct. 8) 1900.

82. Von Winiwarter, J. R.: Ueber Magen-Darmblutungen nach Operationen, Arch. f. klin. Chir. **95**:161, 1911.

83. Meyer, H. H.: Die Pharmakologie des vegetativen Nervensystems, Med. Klin. **8**:1773, 1912.

84. Rössle, A. B.: Das runde Geschwür des Magens und des Zwölffingerdarmes als "zweite Krankheit," Mitt. a. d. Grenzgeb. d. Med. u. Chir. **25**:766, 1913.

85. Korst, L.: Das Magendarmgeschwür und seine Beziehung zu organischen Gehirnerkrankungen, Ztschr. f. d. ges. Neurol. u. Psychiat. **117**:553, 1928.

86. Durante, L.: The Trophic Element in the Origin of Gastric Ulcer, Surg., Gynec. & Obst. **22**:399 (April) 1916.

87. Light, R. U.; Bishop, C. C., and Kendall, L. G.: Production of Gastric Lesions in Rabbits by Injection of Small Amounts of Pilocarpine into the Cerebrospinal Fluid, J. Pharmacol. & Exper. Therap. **45**:227 (June) 1932.

vessels, is a likely explanation of the erosive action and formation of ulcer. Watts and Fulton [88] (1935) also subscribed to this theory.

During four years Hart [89] (1918) found that 17 per cent of the ulcers of the stomach and duodenum observed at postmortem examination were associated with disease of the brain. This exceeded the percentage with which cardiorespiratory or cholecystic disease was associated.

It was Cushing's work [74] (1932) that stimulated renewed interest in this subject. During a period of a few years he lost 3 patients from acute perforation of the upper part of the alimentary canal, the fatalities occurring soon after what appeared to be a successful removal of an intracranial tumor. Each tumor was situated in the cerebellum. One patient had perforating ulcers and inflammation of the stomach; the second had perforating duodenal ulcers, and the third had a perforating ulcer of the esophagus. In reviewing previous postmortem material, he found several more cases in which operation on the brain was associated with gastric and esophageal erosion and ulceration. Masten and Bunts [90] (1934) reported 6 cases of intracranial involvement in which postmortem examination was made. In 2 of these cases there was esophageal rupture; in 1 of these there was gastric erosion, and in the other, gastric perforation. In the 4 other cases there was multiple erosion, perforation or necrosis of the stomach. In none of these cases was there any abdominal distention, nor were any of the patients actively digesting food twenty-four hours before death. Each patient was comatose twenty-four hours or longer before death and could not feel the pain when the rupture occurred. In 3 cases a sudden increase in the pulse rate before death probably indicated the time of the rupture. Histologic examination in all these cases disclosed that the lesions of the alimentary tract were antemortem processes.

In 1933 Keller, Hare and D'Amour [91] showed that intraventricular hemorrhage produces lesions in the gastro-intestinal tract.

By injecting pilocarpine or solution of pituitary into the ventricles of man, Cushing [74] (1932) was able to produce increased motility, hyper-

88. Watts, J. W., and Fulton, J. F.: The Effect of Lesions of the Hypothalamus upon the Gastro-Intestinal Tract and Heart in Monkeys, Ann. Surg. **101**: 363 (Jan.) 1935.

89. Hart, Carl: Betrachtungen über die Entstehung des peptischen Magen- und Zwölffingerdarmgeschwüres, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **31**:350, 1918-1919.

90. Masten, Mabel G., and Bunts, R. C.: Neurogenic Erosions and Perforations of the Stomach and Esophagus in Cerebral Lesions: Report of Six Cases, Arch. Int. Med. **54**:916 (Dec.) 1934.

91. Keller, A. D.; Hare, W. K., and D'Amour, M. C.: Ulceration in Digestive Tract Following Experimental Lesions in Brain-Stem, Proc. Soc. Exper. Biol. & Med. **30**:772 (March) 1933.

secretion and hypertonus of the stomach and esophagus. This led to vomiting, and the vomitus ultimately contained blood. From these results he concluded that there is probably in the diencephalon a parasympathetic center and that:

> From this center, apparently tuberal in situation, fiber tracts pass backward to relay with the cranial autonomic stations of midbrain and medulla of which the vagal nucleus is by far the most important because of its influence upon the activity of the lungs, heart, and upper alimentary canal. Experimental lesions anywhere in the intracranial course of these fiber tracts from anterior hypothalamus to vagal center, presumably from parasympathetic stimulation (or possibly from vagal release due to sympathetic paralysis) are prone to cause gastric erosions, perforations, or ulcers.

Ferguson [92] (1932), on the other hand, found that intraventricular injection of pilocarpine into monkeys immediately stopped the excretion of free acid and lowered the total acid content of the gastric juice. Dodds, Noble and Smith [93] (1934) found that by injecting or giving by mouth a certain extract of the posterior lobe of the pituitary body (chemical composition unknown) he could produce in animals, within from ten to fifteen hours, severe gastritis involving chiefly the acid-bearing portion of the stomach. Klein [94] (1935) stated that in the absence of both vagus and splanchnic nerves pilocarpine could stimulate the gastric cells to secrete pepsin and hydrochloric acid. After stimulation of the cells with pilocarpine, however, atropine inhibited the secretion of hydrochloric acid but not that of pepsin. The action of the pilocarpine persisted after removal of the myenteric plexus. There the sites of action were probably at the neurocellular junction, the cells or possibly the nerve endings of fibers originating in the submucous plexus.

Using monkeys as experimental animals, Sheehan [88] (1934) concluded that his work suggested that there is a central inhibitory influence on gastric movements from the frontal and premotor areas of the forebrain and that there is not sufficient evidence to support the view that there is a sharply localized cortical center of excitation of gastric activity.

Grant's [95] recent work (1935) adequately summarized the question. He expressed the belief that it has been definitely proved that the parasympathetic and sympathetic mechanisms control the integrity of the

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92. Ferguson, J. H.: Central Nervous System in Relation to Digestive Functions, Proc. Soc. Exper. Biol. & Med. **30**:328 (Dec.) 1932.

93. Dodds, E. C.; Noble, R. L., and Smith, E. R.: A Gastric Lesion Produced by an Extract of the Pituitary Gland, Lancet **2**:918 (Oct. 27) 1934.

94. Klein, Eugene: Gastric Secretion: VI. The Action of Pilocarpine on the Secretions of a Transplanted Gastric Pouch Without Auerbach's Plexus, Arch. Surg. **30**:277 (Feb.) 1935.

95. Grant, F. C.: Brain Lesions and Duodenal Ulcer: Report of Two Cases, Ann. Surg. **101**:156 (Jan.) 1935.

gastro-intestinal mucosa. Whether the control is exercised through the maintenance of a proper blood supply, by changes in the acid gastric secretion or by secretion of mucus is not clearly understood.

GENERAL SUMMARY

The anatomic position of the esophageal glands makes them vulnerable to infection from within, and lymphatic connections of the esophagus with the abdominal viscera make the esophagus vulnerable to infections arising in distant organs of the body. Since the submucous veins of the esophagus often assume sinus-like dimensions, hemorrhage probably is frequent following slight trauma.

From the available literature it appears that so-called "peptic ulcer of the esophagus" is only a form of persistent acute or subacute ulcerative esophagitis.

It seems that in a high percentage of patients regurgitation of gastric content into the esophagus is a normal process. The esophageal mucosa is well protected by its own mucous secretion. When this coating is inadequate or an erosion is present the regurgitated gastric juices play an important part in the production of esophagitis. Of the theories of etiology of esophagitis discussed in this paper, that of vomiting seems to be of chief importance. From the available literature it may be concluded that the parasympathetic and sympathetic mechanisms control the integrity of the gastro-intestinal mucosa.

BRONCHOSCOPIC STUDIES OF ABSCESS OF THE LUNG

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The bronchoscopist has always been vitally concerned with suppuration of the lung. His rôle has been twofold: diagnostic and therapeutic. The widespread application of bronchoscopy as a therapeutic measure in this disease will not be discussed. This paper deals with the bronchoscopic findings and their interpretation in cases of abscess of the lung in the acute, subacute or chronic stage. Bronchoscopy is not utilized merely when it is suspected that a foreign body is present in the bronchus.

At the Mount Sinai Hospital the bronchoscopist is frequently called on for an opinion on a thoracic condition. In 1932, of 166 new cases in which bronchoscopic examination was required there were 54 of abscess of the lung; in 1933, of 172 cases, there were 63 of abscess of the lung, and in 1934, of 160 cases, there were 53 of abscess of the lung. There was a total of 39 cases of bronchiectasis in this group. Thus, almost 30 per cent of all the cases in which examination with the bronchoscope was carried out were instances of abscess of the lung. Bronchiectasis occurred in about 12 per cent.

The value of the bronchoscopic examination may be best comprehended by realizing that an abscess of the lung is nearly always at one time or other openly connected with the bronchial tree and that the abscess which occupies a bronchopulmonary segment usually empties directly into a bronchus of the fifth or sixth order. It is therefore apparent that a bronchoscope for examining adults, which is from 7 to 9 mm. in diameter, cannot enter a bronchus which is no wider than a matchstick. Bronchi of the third and fourth order can be temporarily dilated by means of an instrument devised by Yankauer, called the tinker, but the introduction of the bronchoscope itself farther than that cannot be carried out because of the smaller diameter of the more distal divisions. Reputable bronchoscopists have stated that they have been able to enter an abscess cavity, but my experience before, during and after operation has been different. In none of my cases was it possible

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Read before the Medical Society of Sullivan County in the symposium "Abscess of Lung" at Loomis Sanatorium, Loomis, N. Y., May 1, 1935.

to visualize the abscess cavity with the bronchoscope or to drain the contents through the bronchi.

Although the bronchoscope cannot enter the abscess cavity, the examination serves in a useful capacity in localization of the bronchopulmonary segment in which the abscess lodges. The work of Kramer and Glass [1] in accurately placing each segment in a constant position in the pulmonary tree has proved to be of great importance. They showed that each segment is supplied by a constantly placed bronchus, the orifice of which is situated in a large lobar bronchus and is easily visible on bronchoscopic examination. Identification of the orifice leads to recognition of the associated segment. Bronchoscopic examination, by visualizing the bronchial orifice, can reveal the position and extent of the pathologic process in the lung and define the area to be exposed by the surgeon.

BRONCHOSCOPIC OBSERVATIONS

The most reliable single bronchoscopic sign of pulmonary abscess is the escape of foul pus from the mouth of the bronchus. The pus from a putrid abscess of the lung is usually not so great in amount as that from bronchiectatic cavitation. Occasionally in the early stage a foul odor is perceptible, but pus cannot be found. Among other causes, the absence of pus may be due to marked edema about the orifice of the bronchi. Case 1 demonstrates how this may happen.

CASE 1.—M. M., a Negress 42 years old, was admitted to the hospital with a history of cough, night sweats and fever and profuse sputum for four weeks. Physical examination revealed dulness at the level of the fourth rib on the left side posteriorly to the base, over which breath sounds were prolonged on expiration, and occasional coarse râles were heard. At first it was thought the patient had pulmonary tuberculosis. A roentgenogram of the chest showed a pneumonic infiltration of the middle third of the left lung, extending from the level of the sixth to that of the ninth rib. Posteriorly, in the upper part of the infiltration was a small cavity with a fluid level. The appearance in the roentgenogram was suggestive of abscess of the lung. Bronchoscopic examination revealed the orifice of the apical branch of the bronchus of the lower lobe of the left lung to be completely closed by edematous mucosa. After some search the orifice was found. The opening was dilated, and there was an evacuation of foul, creamy pus.

From experiences such as this the bronchoscopist will often suggest repeated bronchoscopic examination when odor without pus is present. After the acuteness of the process and the swelling subside and pus makes it appearance, more satisfactory examination can be made and a more definite diagnosis can be established. Occasionally, in cases of cortical abscess, especially those in which the abscess has ruptured, the

1. Kramer, R., and Glass, A.: Bronchoscopic Localization of Lung Abscess, Ann. Otol., Rhin. & Laryng. **41**:1210 (Dec.) 1932.

odor may be detected through the bronchoscope but pus is not demonstrable. This is of great importance in the clinical diagnosis of an otherwise obscure condition.

The tracheobronchial tree is frequently congested and swollen. The mucous membrane of the bronchial orifice leading to the abscess is usually red and angry-looking. Granulations may be present, or the mucous membrane itself may have a granular appearance. These changes in the mucous membrane are important in the differentiation of the origin of the pus in the bronchial tree, some of which may spill over to adjacent bronchi and make localization more difficult. Local changes in the mucous membrane of the diseased orifice thus provide an important diagnostic clue. Occasionally findings point to actual gangrene of the lung. In 1 case, in a patient with a four day history of fever and profuse expectoration that was intensely foul, almost fecal, and bloody at times, the roentgen observations showed marked involvement of the lower lobe of the right lung, with cavitation and fluid level. Apparently a bilocular abscess cavity was present in the lower lobe. Bronchoscopic examination disclosed a profuse watery, black discharge, with an odor suggesting burnt feathers, from the apical, the posterolateral and the lower vertebral branch of the lower lobe of the right lung.

In the subacute stage, the adjacent divisions of the same lobe may show similar changes in the mucous membrane. Similar changes may be present in the other lobes. This represents a rather extensive spill-over and perhaps secondary infection. If the spill-over is observed early, the mucous membrane of the bronchus may be so swollen as to occlude the opening of the bronchus. As the condition progresses into a chronic stage, secondary bronchiectasis develops. The pus from the bronchiectatic cavity is usually foul, but after a long interval the foul odor may disappear. This may indicate bronchiectasis around a shut-off abscess.

Perforation through a fissure may permit the expulsion of pus from bronchi draining the adjacent lobe as well as from the primary abscess. Extensions of this sort may be recognized by the bronchoscopist, as is demonstrated in case 2.

CASE 2.—H. Z., a man aged 54, was admitted to the hospital with pulmonary symptoms which began five and one-half months previously with chilliness, fever and a dry cough. After a short time the symptoms became violent. Two weeks later sputum appeared in copious amounts, with occasional small quantities of blood. A foul odor of the breath was noted both on expiration and on coughing but not in the sputum. Physical signs were insufficient for diagnosis. Dulness was present at the apex of the right lung. Bronchoscopic examination revealed pus coming from branches of the upper lobe of the right lung, which were dilated. The patient was advised to have an operation but refused. He returned one year

later with a history of recurrence of foul expectoration, hemoptysis and fever. The roentgenograms and bronchograms showed extension of the pulmonary suppuration from the upper to the middle lobe. Bronchoscopic examination revealed odorless pus coming from the anterior division of the upper lobe of the right lung and also from the branches of the middle lobe, both of which were dilated. Postmortem examination revealed a chronic abscess of the upper lobe of the right lung, no longer putrid, involving the axillary and anterior regions, communicating with a more recent abscess of the same lobe and extending into the axillary division of the middle lobe.

Other bronchoscopic findings are those of distortion of the trachea, deformity of the carina, obstruction of bronchi, distortions of the bronchi, which are often associated with granulation tissue, and stenosis occurring in the fibrotic stage. The stenosis may be so marked as frequently to obstruct the bronchial lumen. Often such stenotic lesions are noted at the site of foreign bodies which have been removed. Biopsies of these infiltrations show acute and chronic inflammation. Biopsy is warranted in every case of stenosis or distortion because of the possibility that the suppuration in the lung may be a complication of an undiagnosed bronchogenic carcinoma. In a series of 100 postmortem examinations in cases of abscess of the lung to be reported on by Kramer and Som, 14 revealed secondary abscess of the lung due to bronchial carcinoma. In 6 cases the infection was putrid, and the clinical diagnosis of abscess of the lung had been made. On bronchoscopic examination a bronchial carcinoma was found which was responsible for the anaerobic infection distally. The bronchoscopic picture of abscess of the lung with carcinoma may show edematous mucosa, which narrows the lumen of the bronchus infected and may only be slightly altered by the presence of the infiltrating growth. Biopsy is, of course, necessary for diagnosis. Distortion of the bronchi and signs of extrabronchial pressure, in addition to those of pulmonary abscess, should lead to suspicion of carcinoma. In 5 cases of bronchogenic carcinoma complicated by abscess of the lung, distortion was prominent. Distortion of the bronchus due to primary abscess per se is relatively rare.

INDICATIONS FOR BRONCHOSCOPIC EXAMINATION

In cases of suspected abscess of the lung bronchoscopic examination is important and may give valuable information. This information is supplied by the character of the pus and the odor emanating through the bronchoscope, detection of the possible causes of the abscess and incidental findings in the search, which may be of paramount importance, a general survey of the bronchial tree and, the most important function, localization of the putrid abscess for the surgeon preliminary to his operative approach. Striking information can be gained by the detection of odors through the bronchoscope. I have learned to asso-

ciate a sewer-like odor with an abscess, an odor of stale fish with bronchiectasis and a strawlike odor with infection of the lung due to bacteria of a higher order. The presence of a foul odor without the presence of actual pus in the bronchial tree in a case in which the condition was suspected clinically of being abscess of the lung corroborated that diagnosis. A check-up bronchoscopic examination at a further date, or exploratory operation, has proved in each instance that an abscess was present. On the other hand, the absence of odor from pus does not preclude the presence of an abscess. Due consideration, however, is given the presence of pus coming from a single division and reappearing after suction from that division only. This point is of special importance in cases of lesions of the upper lobe in which abscess, bronchiectasis, pneumonitis and tuberculosis have to be differentiated.

Local conditions in the bronchus which may play a rôle in the development of the abscess can be determined by bronchoscopic examination. Foreign bodies in the bronchus must be considered. Aspirated foreign bodies which have caused abscess of the lung are not uncommon. Benign and malignant tumors simulating abscess of the lung must be looked for. Inflammatory strictures or tracheo-esophageal fistulas may also be found. Cases of abscess of the lung in which thoracotomy was done without previous bronchoscopic examination and in which bronchogenic carcinoma with an abscess was noted later have also been observed. In several cases in my series there has been adenoma of the bronchus, the presence of which was not suspected until bronchoscopic examination. The history in case 3 suggested the presence of a foreign body.

Case 3.—D. B., a man 29 years old, had had a nasal polyp removed four and a half months previously, followed by a whistling sensation in his chest and the production of 20 cc. of foul sputum daily. Physical examination revealed dulness and flatness in the lower lobe of the right lung. Bronchoscopic examination revealed the main bronchus of the right lung just below the carina to be occluded by a mass of firm tissue arising from the anterior wall, gradually involving the posterior wall. Tissue was removed for study. There was a profuse flow of thick pus from the lower lobe. The tissue proved to be adenoma. On the second bronchoscopic examination pus was not present, and more tissue was removed. Further bronchoscopic examinations were carried out; diathermy was used; the growth was removed, and the patient was cured.

Accurate localization of the abscess by the bronchoscopist is imperative. This is necessary, although it may merely confirm the roentgenologic and physical findings. In the acute stage usually a single branch is involved. In the subacute and chronic stages one or more divisions and one or more lobes may be involved. This may be caused by spillover or by infection due to extension. Secondary bronchiectasis must be differentiated from an original abscess of the lung. For example, in 1 case an abscess of the middle lobe of the right lung following the

spontaneous perforation of a peritonsillar abscess was neglected for two years. Bronchoscopic examination revealed foul pus coming from the axillary division of the bronchus of the middle lobe of the right lung and also from all the branches of the bronchus of the lower lobe. But the mucous membrane of the bronchi of the lower lobe was normal, while the orifice of the middle lobe was red and angry-looking. Studies with iodized poppy-seed oil 40 per cent confirmed this observation before operation was performed. Localization of the extension of residual or secondary infections, either gangrenous or bronchiectatic, after operation is also necessary. Despite adequate surgical intervention, the patient may continue to have sputum, fever and signs, and a new suppurative site may be present. The symptomatology demands further bronchoscopic examination for localization. In addition, bronchoscopic examination has an important application after thoracotomy, since it is useful in a determination of the status of the condition by the amount and the extent of the overflow into the bronchus and of changes in the bronchial picture, such as exacerbation and fresh acute processes or extension of the disease at the periphery of the lung into an adjacent segment. In cases in which surgical treatment is instituted and proper progress has not been made, it is advisable to make a bronchoscopic examination. Foreign bodies may be found and removed. The finding of other abnormalities, e. g., carcinoma or stricture, may explain the failure to heal. In 1 of my cases, after an unsatisfactory thoracotomy a tack was removed by bronchoscopic manipulation.

COMMENTS AND CONCLUSIONS

The experiences cited with bronchoscopy reveal its best application in the diagnosis of abscess of the lung at its various pathologic stages: The diagnosis can be made before the expectoration of pus; it offers aid in finding and removing the causes of abscess of the lung; it helps the surgeon before operation by accurately localizing the site of the involved bronchopulmonary segment which lodges the abscess cavity, and it is valuable in determining the course of the surgically treated pulmonary lesion.

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ACUTE LARYNGOTRACHEITIS IN CHILDREN

A STUDY OF FORTY-THREE CASES OCCURRING AT THE CHILDREN'S HOSPITAL, LOS ANGELES, IN EPIDEMIC FORM, DURING THE FALL AND WINTER OF 1933-1934.

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Nondiphtheritic laryngotracheitis is a term more descriptive of a single phase of an infection of the upper respiratory tract than of a clinical entity.

In certain epidemics of various diseases there appear organisms which have a definite affinity for certain tissues. Experience has shown that some winters there will be a greater incidence of cases of infection of the mastoid although there does not appear to be any increase in the number of cases of infection of the upper respiratory tract. Similarly, some years will yield a greater number of cases of empyema following pneumonia despite the fact that there is not an increased prevalence of pneumonia. This selective phase of an apparently mild infection of the upper respiratory tract has been clearly shown during the winter season of 1933-1934 in and about Los Angeles. As a result, I have collected a series of forty-three cases of laryngotracheitis, in all of which the patient was so ill as to warrant hospitalization. My object in this paper is to discuss the findings in this series and to state certain conclusions that have been reached as a result of this study.

HISTORICAL NOTE

Acute laryngotracheitis is not a new condition but rather an unrecognized one. In 1914 there appeared a few scattered reports of cases, but during the last six years such reports have become more prevalent in the literature.

Attention was called to a similar form of this condition by Morris [1] in 1917. He reported three fatal cases at the Willard Parker hospital in which the condition developed following measles. In two of these culture for Klebs-Löffler bacilli gave negative results and in one case

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This paper is a thesis submitted to the faculty of the Graduate School of Medicine of the University of Pennsylvania, in partial fulfilment of the requirements for the degree of Master of Medical Science (M. Sc. [Med.]) for graduate work in otolaryngology.

1. Morris, M. E., Jr.: Laryngeal Stenosis as a Complication of Measles, New York M. J. **106**:1125 (Dec. 15) 1917.

a culture was not made. He concluded that laryngeal stenosis is a too frequent complication of measles and advised intubation.

In 1919 Tuley [2] reported a fatal case of laryngeal edema following influenza. During the same year E. D. Smith [3] reported recovery in such a case after tracheotomy was performed.

Harmon Smith [4] in 1924 reported four cases of fulminating septic infection of the pharynx and larynx, with a fatal result in one. Hemolytic streptococci were found in all four cases.

Daily and Allen [5] in 1926 reported a typical case of this type of infection in an 8 year old boy who recovered after tracheotomy was performed.

Baum [6] in October 1928 presented a paper on this subject in which he reported twenty-four cases that he had collected during a period of eight years. Since then he has made other contributions on the same subject.

Tucker [7] has given valuable information in regard to the anatomy of the infant larynx, the signs of obstructive dyspnea and the manner in which the latter should be combated.

Others, among them Richards,[8] Bradford and Leahy,[9] Gittins,[10] Johnson,[11] Husik,[12] Berry,[13] Thomson,[14] Leigh,[15] Mainzer,[16] Hart,[17]

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2. Tuley, H. E.: Fatal Laryngeal Edema Following Influenza, Kentucky M. J. **17**:315 (Aug.) 1919.

3. Smith, E. D.: Tracheotomy for Edema of the Larynx Complicating Influenza, Kentucky M. J. **17**:282 (July) 1919.

4. Smith, Harmon: Fulminating Septic Infection of Pharynx and Larynx, Ann. Otol., Rhin. & Laryng. **33**:1339 (Dec.) 1924.

5. Daily, L., and Allen, N. A.: Unusual Case of Acute Infection of Epiglottis and Larynx: Tracheotomy and Recovery, Laryngoscope **36**:367 (May) 1926.

6. Baum, Harry L.: Acute Laryngotracheobronchitis, J. A. M. A. **91**:1097 (Oct. 13) 1928.

7. Tucker, G.: (*a*) The Infant Larynx: Direct Laryngoscopic Observations, J. A. M. A. **99**:1899 (Dec. 3) 1932; (*b*) Bronchoscopic Observations on Obstructive Pulmonary Atelectasis, Arch. Otolaryng. **13**:315 (March) 1931; (*c*) Obstructive Dyspnea: Bronchoscopic Observations; Types, with Illustrative Cases, Southern M. J. **25**:723 (July) 1932.

8. Richards, Lyman: Fulminating Laryngo-Tracheo-Bronchitis, Ann. Otol., Rhin. & Laryng. **42**:1014 (Dec.) 1933.

9. Bradford, W. L., and Leahy, A. D.: Acute Obstructive Laryngitis: Clinical and Bacteriologic Study in Sixty-Six Cases, Am. J. Dis. Child. **40**:298 (Aug.) 1930.

10. Gittins, T. R.: Laryngitis and Tracheobronchitis in Children: Special Reference to Nondiphtheritic Infections, Ann. Otol., Rhin. & Laryng. **41**:422 (June) 1932.

11. Johnson, M. C.: Acute Laryngotracheobronchitis in Infants: Report of Three Cases, Arch. Otolaryng. **17**:230 (Feb.) 1933.

12. Husik, D. H.: Acute Laryngeal Edema, Laryngoscope **36**:352 (May) 1926.

(Footnotes continued on next page)

Bugg,[18] Hyde and Ruchman,[19] Codd [20] and Seitz,[21] have made noteworthy contributions to this subject.

ETIOLOGY

In the severe form of acute laryngotracheitis age is a predisposing factor. In the series of cases reported here the youngest patient was 6 months of age and the oldest 7 years. The predominating age was from 12 to 24 months, seventeen patients, or 39 per cent of the total, being included within this age limit. The remaining patients were evenly distributed as to age for each year up to the age of 7. These findings agree with most of those previously reported.

The greater prevalence in the lower age limits can be accounted for in that in younger children there is a predominance of loose areolar tissue in the subglottic area that easily allows edema to form and mechanically shut off the trachea. Also Tucker [7a] has shown that the epiglottis in the infant is narrow and has a tendency to fold longitudinally, thereby elevating the aryepiglottic folds and making the entrance to the larynx smaller in proportion to its other dimensions in the infant than in the adult. The glottis is also smaller proportionately, the anteroposterior measurements being from 7 to 9 mm., with a subglottic larynx from 1 to 2 mm. less in the same person. The tracheal diameter is several millimeters greater than the subglottic larynx.

Unlike Bradford and Leahy,[9] who stated that the disease is one of spring and summer, I found it to be of fall and winter frequency. This series appeared in the form of a mild epidemic, the peak being reached during November. In July there was one admission to the hospital, and in August there were three more; nine patients were

13. Berry, G.: Case report: Membranous Laryngitis and Tracheitis with Staphylococcus Aureus Hemolyticus Infection, Ann. Otol., Rhin. & Laryng. **37**: 960 (Sept.) 1928.

14. Thomson, C. A.: Acute Stenotic Laryngitis Simulating Laryngeal Diphtheria, J. A. M. A. **78**:1456 (May 13) 1922.

15. Leigh, H.: Sudden Death from Acute Laryngeal Obstruction of Non-Diphtheritic Origins: Report of Cases Occurring During Winter Epidemic and Autopsy Findings, Southwest. Med. **11**:210 (May) 1927.

16. Mainzer, F. S.: Acute Laryngotracheobronchitis, Pennsylvania M. J. **33**: 24 (Oct.) 1929.

17. Hart, V. K.: Streptococcic Laryngitis: Report of Case with Very Rare Complication, Ann. Otol., Rhin. & Laryng. **36**:761 (Sept.) 1927.

18. Bugg, C. R.: Acute Laryngeal Obstruction in Children, South. M. J. **24**: 1057 (Dec.) 1931.

19. Hyde, C. I., and Ruchman, J.: Acute Infectious Edematous Laryngitis in Which Recovery Followed Tracheotomy, Arch. Pediat. **48**:124 (Feb.) 1931.

20. Codd, A. N.: Obstructive Laryngeal Dyspnea, Ann. Otol., Rhin. & Laryng. **40**:242 (March) 1931.

21. Seitz, R. P.: Acute Streptococcic Laryngitis in Children: Report of Cases, California & West. Med. **30**:259 (April) 1929.

admitted during September and a like number in October. In November the peak was reached, with thirteen admissions, and then a decided decrease took place, with five admissions in December, three in January and none in February and March.

Sex appeared to play a part, as was also shown by Bradford and Leahy,[9] who found that in twenty-eight cases boys predominated in the ratio of 3:1. In this series of forty-three cases, there were thirty-two boys and eleven girls, practically a ratio of 3:1.

The presence or absence of tonsils and the part they play cannot be justly considered because of the age of the patients. Over 50 per cent of the cases occurred before the age of 2 years, which is certainly a pretonsillectomy age.

In eleven of the patients there was a history of infection in the family. Often this was shown by the presence of pharyngitis or rhinitis in the father or mother. In several instances brothers and sisters had similar attacks of much less severity several days before. In none of my cases did the condition follow any of the diseases sometimes responsible for laryngeal edema, such as measles, scarlet fever, typhoid, pneumonia, influenza or smallpox. In all it appeared to be a part of the picture of an infection of the upper respiratory tract that occurred in epidemic form.

Bacteriologically, as most authors have found, the streptococcus appears to be the chief offending organism, although it is usually found in conjunction with other bacteria. Streptococcus haemolyticus was present in twenty-six cases, it being found in eighteen cases in the alpha prima form and in eight cases in the beta form; Streptococcus viridans (alpha) was found in twenty-three cases, Staphylococcus aureus in seventeen, pneumococcus in five, Micrococcus catarrhalis in three, Staphylococcus albus in two and Micrococcus pharyngis in one case. In the four fatal cases the severity of the symbiotic relationship of Str. haemolyticus and Staph. aureus was shown in that it was found to occur in three of the cases. In the one other fatal case, Str. haemolyticus (beta) was responsible. In one of the three fatal cases a positive blood culture for Staph. aureus and Str. haemolyticus was also found.

PATHOLOGIC CHANGES

Necropsy was performed in three of the four fatal cases.

Examination of J. J., a boy aged 11 months, showed extensive pathologic changes. There was edema of all of the soft tissues of the larynx. The mucous membrane of the epiglottis was greatly thickened and edematous. The corneiform and corniculate tubercles did not stand out prominently but were blended together in marked edema. The true vocal cords and the ventricular folds were edematous. Edema was also marked in the mucous membrane opposite the cricoid lamina and downward to the first tracheal cartilage. From this point down edema was not so marked, but much congestion was present. The mucous membrane of the trachea

and bronchi to the minute ramifications in the lungs was markedly reddened and congested. The lungs were the seat of moderate edema and congestion, especially on the right side. There was in addition pneumothorax on the right side. Microscopic sections showed marked edema of the soft tissues in this location, with moderate cellular infiltration of these structures. Infiltrating cells were round cells and in a rare instance polymorphonuclear leukocytes. The surface epithelium was desquamated in some places, and in other locations it was found to be necrotic. The gland tubules were filled in many instances with necrotic débris and cellular material. The trachea showed round cell infiltration of the soft structures. Culture of the epiglottis and trachea showed Str. haemolyticus (beta type), Staph. aureus and Bacillus coli.

In the other two cases the pathologic pictures were almost identical. In one case there was bilateral pneumothorax and in the other unilateral pneumothorax. There was considerable hyperemia in the mucosa of the lower part of the larynx and trachea. The mucosa was swollen, and there resulted a greatly decreased lumen of the air passages from the level of the vocal cords down to the trachea.

Microscopic sections taken in these two cases showed necrosis of the surface epithelium, with marked edema of the tissues surrounding the glands. There was marked round cell infiltration, the cells being lymphocytes and an occasional plasma cell and polymorphonuclear leukocyte. Swelling was so extensive that it greatly increased the thickness of the soft tissues in the region. Some of the sections showed more necrosis of the surface epithelium than did others, and in many places in which this process was the most marked there was a complete loss of the surface epithelium. Sections taken from the trachea showed a loss of the surface epithelium, edema and round cell infiltration of the soft structure of the trachea.

Sections stained for bacteria showed the presence of large numbers of gram-positive cocci in the necrotic material just beneath the surface epithelium, with extension into the glandular elements and slightly into the subglandular tissue.

In all three cases there was a collapse of either one or both lungs. This is explained by the formation of plugs or the accumulation of secretions that blocked the bronchi in that particular location. Tucker [7b] reported several cases of pneumothorax due to this cause, two of which I will cite. One was that of an 18 year old nurse in whom massive collapse of the entire left lung occurred thirty-six hours after operation for appendicitis. Tucker examined the patient bronchoscopically and aspirated a considerable quantity of thick obstructive secretion from the left main bronchus and the bronchi of the upper and lower lobes of the left lung and their subdivisions. Pain and dyspnea subsided at once, and roentgenologic examination twelve hours later showed the heart to be in the normal position. He also reported the case of a 12 year old girl with bronchial asthma in whom during a severe attack pneumothorax developed, which was subsequently relieved by aspiration of a large quantity of secretion which had accumulated in the bronchi.

SYMPTOMATOLOGY AND DIAGNOSIS

As Richards [8] stated, laryngotracheitis should always be thought of with two other important clinical entities, viz., (1) diphtheria and (2)

a foreign body. Even in the face of an epidemic, these two conditions should always be ruled out.

In all of the cases in this series the condition was accompanied by some signs of an infection of the upper respiratory tract. Many of the patients had nothing more than mild pharyngitis or rhinitis for from twelve to forty-eight hours preceding definite symptoms that pointed to an infected and inflamed larynx.

Hoarseness was the outstanding symptom, though it was not always present because the edema is more marked below the level of the true vocal cords. This dysphonia often progressed until a stage of complete aphonia was reached. There was associated a dry croupy irritative type of cough, nonproductive in character.

As the edema progressed, the effects of mechanical obstruction became manifest. Retraction, the one sign pathognomonic of obstructive laryngeal dyspnea, took place. It is the characteristic indrawing at the suprasternal notch, the epigastrium and the intercostal and supraclavicular spaces on inspiration. Tucker [7e] stated:

> The obstruction is greatest on inspiration because of the trap-door-like action of the vocal cords. The floor of the ventricle of the larynx is higher at the margin of the cord than it is at the outer side of the ventricle. The air passing inward has a tendency to pull the cords together, narrowing the glottis. This produces an increase in negative pressure on the inside of the chest with resultant typical indrawing. This sign appears early, particularly in children, is worse on exertion, and becomes progressively more marked as the obstruction increases. Usually stridor and wheeze are present.

Along with retraction goes a concomitant sign, restlessness. The child appears anxious and frightened, usually tries to sit or stand up in its crib and is constantly changing its position in an attempt to obtain more air. As the condition becomes progressively worse, there develops a peculiar type of cyanosis that results not only from a limited supply of oxygen but from cardiac exhaustion. It is marked by a paleness rather than the usual blue type of cyanosis. In fact, when the latter stage is reached the child is usually moribund and beyond aid.

Inspection by direct laryngoscopy usually showed the pharynx, epiglottis and larynx to be hyperemic. In a few cases there was marked edema of the epiglottis, the arytenoid and adjacent structures. However, in most cases these changes were confined to the subglottic region.

No actual membrane was present in any of these cases, although in a few there was a purulent sticky secretion which adhered to the walls but could be easily removed without any resultant bleeding. This secretion, which was usually present in a moderate to a profuse amount, had a very high viscosity on account of its fibrin content.

As a result this acted as a check valve when it formed into plugs that shut off the bronchi. In cases in which pulmonary complications followed there was an increase in secretion and it became more fluid.

Pulmonary findings at the outset were not a promient feature. In twenty-nine cases the chest was normal. Of the twelve cases in which tracheotomy was performed there were only five in which positive signs were observed.

The temperature, while not greatly elevated, showed evidence of an infection. On admission nine patients had a normal temperature. (All temperature readings were rectal.) Eight patients had a temperature of from 100 to 101 F.; eleven, from 101 to 102 F.; six, from 102 to 103 F.; seven, from 103 to 104 F., and one each, from 104 to 105 F. and 105 to 106 F. Of the patients on whom tracheotomy was performed, two had a normal temperature; three had temperatures ranging from 101 to 102 F.; two, from 102 to 103 F., and four, from 103 to 104 F. One patient was moribund, with a temperature of 105 F. Practically all patients on whom tracheotomy had been performed showed a sudden rise in temperature of 3 or 4 F., which gradually receded to the normal limits unless complications intervened. In the cases of milder involvement in which tracheotomy was not necessary, the temperature was often normal on the second day and practically always reached the normal limits after from five to six days.

The blood count was not very conclusive. The red blood cells and hemoglobin were not greatly altered from normal. The hemolytic streptococcus was the predominating organism, but it is probable that the rapidity of the infection did not allow sufficient time for a great change to take place.

The white cell count in most cases was in the normal range. In five cases it was under 5,000 cells per cubic millimeter; in twenty it ranged from 5,000 to 10,000; in fourteen, from 10,000 to 15,000; in three, from 15,000 to 20,000, and in one, from 20,000 to 25,000. In one case there were over 25,000 white cells per cubic millimeter. Of the patients subjected to tracheotomy, one had a white cell count ranging from 6,000 to 7,000; two, from 7,000 to 8,000; two, 8,900; three, from 10,000 to 11,000; one, from 14,000 to 15,000, and three, from 15,000 to 16,000. Hence one sees that even in the cases in which tracheotomy was necessary the white cell count in 66 per cent ranged between 6,000 and 10,000.

TREATMENT

Palliative treatment was considered only for the patients with mild involvement in whom retraction was not present or, if so, was very mild and was not increasing. As with any acute toxemia, such measures as a high intake of fluids, the administration of antipyretics and hydro-

therapy were all employed. Inhalations of tincture of benzoin were used, and the room was kept at a constant temperature. The latter was accomplished by a standard procedure which was adopted in cooperation with the department of pediatrics as follows: All doors and windows of the room were to be kept closed; the transom over the door entering the hall was allowed to remain open. A croup tent was constructed by means of a metal frame draped with sheets, so that the bed was completely covered with the exception of one side. The croup kettle was adjusted so that its vapor spout entered the tent at the foot of the bed. Thermometers were placed in the croup tent and in the room. Hourly observations of both thermometers were recorded, and an even temperature of from 76 to 78 F. was maintained in the room. In the tent a slightly higher temperature of from 80 to 82 F. was maintained.

Sedatives were rarely given. They are always contraindicated in the presence of any retraction or difficulty with respiration. In cases of obstructive dyspnea there is no spasm to allay, and hence morphine is contraindicated. If given in sedative dosage it will often stop the action of the accessory respiratory muscle, and asphyxiation will result.

The giving of "respiratory vaccine" [22] in a large dosage has been advised by Forbes and Baum,[23] of Denver, for an abortive effect on the infection when the patient is seen early. Their technic is to give 0.25 cc. of double-concentrated vaccine early and to repeat it in from twelve to twenty-four hours if necessary, depending on the reaction. Then they increase the dose to 0.5 cc. if the first dose does not cause the desired effect. Within ten hours after the first dose, if a tracheotomy is not necessary, one can assume that the patient is out of danger.

For patients with the severe form something must be done, and delay is dangerous. Surgical intervention is usually called for, which in twelve of the patients in this study consisted of tracheotomy. Local anesthesia was of course employed, general anesthesia always being contraindicated on account of its effect on the accessory muscles of respiration.

Two factors are essential for a good tracheotomy, viz., (1) someone to hold the head and neck properly and (2) an assistant who can handle retractors correctly. It is preferable to precede tracheotomy with bronchoscopy, leaving the bronchoscope in place. Tracheotomy can then be done with greater leisure and ease because the trachea will be easily identified with the tube in it, and at the same time there is no asphyxiation. It is often very difficult to locate the trachea in a fat, short-necked infant of about from 12 to 15 months of age.

22. This vaccine is a polyvalent vaccine containing strains of Staphylococcus, Streptococcus coli and Pneumococcus.

23. Personal communication to the author.

As important as the operation is adequate posttracheotomy care. A qualified nurse should be in constant attendance. A duplicate tracheotomy set and equipment should be at the bedside, and suction should be available and used. The inner tube should be removed and cleansed as often as necessary. This may be every five minutes, but it must be done and the airway kept clear; otherwise, as Jackson has so often stated, "the child will drown in its own secretion."

The secretion often becomes more viscid and as a result forms plugs of mucus that tend to obstruct the bronchi. The placing of a piece of gauze moistened with a weak solution of sodium bicarbonate over the tracheotomy tube will offset this drying effect to some extent. If plugs form, however, bronchoscopic drainage is indicated at once; otherwise collapse of the affected portion of the lung takes place, the condition progresses and asphyxiation and exhaustion result.

RESULTS

As most observers have found, the mortality from this condition is high. In this series of forty-three patients, twelve, or 27.9 per cent, required surgical intervention in the form of tracheotomy. Of the twelve so treated, four died—a mortality of 33.3 per cent. Considering the entire series, there was a mortality of 9.3 per cent.

SUMMARY

1. Acute nondiphtheritic laryngotracheitis in infants and children may occur in epidemic form.

2. The pathologic process is found principally in the subglottic tissues. This is because in the infant and the small child there is a predominance of loose areolar tissue that allows swelling to occur and shut off the airway.

3. The findings in cases of severe involvement are those of air hunger, viz., retraction and restlessness.

4. The condition calls for immediate action, and surgical intervention should not be delayed.

5. Provision must be made for adequate postoperative treatment.

6. The condition results in a high mortality.

SCOPE OF PHYSICAL THERAPY IN OTOLARYNGOLOGY

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Physical therapy has become part and parcel of scientific medicine and surgery only recently. Though natural remedies have instinctively been resorted to by mankind in its most primitive stage, it was not until scientific research was sufficiently developed to free many phases of medicine from empiricism that the duad of pharmacal and operative therapy could be enlarged to a triad by the inclusion of physical therapy. Not until means were found to explain why light, air and heat are beneficial in health and disease and not until certain epochal discoveries in physics and technology enriched the therapeutic armamentarium was physical medicine accorded its present scientific status. One need only think of the advances made possible through the discovery of the incandescent light bulb, of the roentgen rays and of the radio to appreciate their importance to scientific medicine.

As one began to realize the clinical value of physical measures it was natural for progressive otolaryngologists not to fall behind. With consideration of the fact that the specialty of otolaryngology is concerned with the entire gamut of infectious, traumatic and neoplastic diseases of the ear, nose and throat, which differ from similar diseases elsewhere in the human economy only in their more difficult recognition and management conditioned by anatomic peculiarities, it was recognized that, once made technically applicable, physical measures should also be employed in its practice. Otolaryngologists have at all times recommended external application of heat as an adjuvant and referred patients with malignant neoplastic disease for radium or roentgen therapy, but between these extreme poles of a household remedy and separate specialistic work comparatively few make systematic use of recognized physical measures in their routine practice.

With the recognition of the therapeutic properties of physical agents the industries have produced appliances to meet all special conditions. In other words, just as the instrument maker's art has provided instruments facilitating diagnostic and operative procedures in the deepest

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Read by invitation before the Detroit Oto-Laryngological Society, Nov. 20, 1935.

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recesses of the ear, nose, throat and larynx, so every physical agent is now available for otolaryngologic practice. There remains, therefore, for the otolaryngologist but to consider the indications and therapeutic value of the thermal, photochemical and electrolytic effects of the available physical agencies to establish their legitimate place in otolaryngology. I shall endeavor briefly to sketch the armamentarium of the otolaryngologist and the methods of clinical application, and this in a general practical way rather than as a recondite study of the underlying physical and biologic processes.

PHOTOTHERMY AND PHOTOTHERAPY

Nature's greatest source of heat, the sun, is neither always available for medical practice nor subject to the precise control so essential for the treatment of regional disorders. There are for clinical purposes a large variety of implements for the external application of heat. The time-honored hot water bag or bottle, the electric pad and rubber coils permitting a flow of water at any desired degree of heat are widely used household appliances, often employed on the advice of the otolaryngologist. They are hardly proper appliances for use by the specialist. For office or clinical practice there is available a large variety of radiant heaters, incandescent lamps and so-called high frequency apparatus. Their selection depends to a certain extent, at least, on the nature of the disorder for which one or the other form of heat is indicated.

Physicians have come to accept as law that inflammation is a reactive process and that by augmenting an existing hyperemia one overcomes the underlying infection. This is evidenced by a subsidence of the phenomena, including distressing painfulness. In acute infections encountered in otolaryngologic practice, including dermatologic inflammations and suppurations of the auricle and external auditory canal, as well as bacterial infections of the nose, throat, inner ear, sinuses, larynx and trachea, the best results are obtained by photothermic treatment, that is, by application of light and heat combined. Theoretically, at least, one will have to assume that while heat per se produces an arterial or active hyperemia, in photothermy one has an energy additional to the heat, which undoubtedly plays a definite rôle in the management of acute infections.

For photothermic therapy the best apparatus is an incandescent bulb type of lamp, though a simple infra-red generator will serve the purpose. The technic of applying radiant heat to any area is simplicity itself. The patient is made as comfortable as possible in the sitting or recumbent posture, and the affected part is exposed to the rays of the lamp at a distance that will permit prolonged irradiation without discomfort. The specialist need but test the heating effect of a given

lamp on the back of his own hand to estimate the proper dosage of the heat in both degree and duration. Half an hour may be accepted as the average time of exposure, except in the case of exquisitely painful conditions, for which empiric tests have shown that lessened intensities at longer periods have brought about decided relief.

It is difficult to understand but is a fact, nevertheless, that in some quarters doubt persists concerning the therapeutic value of heat. Such prejudices have largely been overcome by the recently reported successes with artificially induced fever. Sonne [1] found that the infra-red rays from a carbon arc lamp set up a cutaneous erythema which in experimental animals led to the formation of blisters as a result of the rapid rise of the temperature of the skin. Mayer [2] called attention to the fact that in attempts to establish claims for the beneficent action of heat radiation the process has been likened to that seen in experimental animals, which with raised body temperatures manifested a greater tolerance of infection than under conditions with lower temperatures. From these observations, as well as from countlesss clinical experiences, it is clearly evident that the immediate effects of heat rays on tissues are due to increase in temperature. As a matter of fact, in the treatment of infections during the acute stage, it is not so much a question of a particular kind of apparatus as of the attainment of the desired rise of temperature in the tissues. Once this is attained one observes a localized active hyperemia with its typical changes in the blood in the sense of enhanced phagocytic defense. When, however, combined sources of light and heat have been brought into play, comparative clinical studies have demonstrated superior effectiveness which obviously is ascribable to a distinctly chemical reaction produced by the radiation.[3] Such striking demonstrations have been seen again and again in infections of the upper respiratory tract, even when the patient was subjected to that type of photothermy commonly called infra-red. Though with the naked eye one perceives no phenomenon other than is seen from a heated electric toaster, for example, one soon beholds effects which are not as easily or as rapidly obtainable with conductive heat agencies, namely, profuse drainage, relief of stasis and increase of local metabolism and oxidation. The application of the high frequency current for heat effect will be discussed separately.

Light itself, that is, light without therapeutic thermal energies, also is provided by nature in the sun, which, as is well known, is utilized

1. Sonne, Carl: The Mode of Action of the Universal Light Bath, Acta med. Scandinav. **54**:336, 1921.

2. Mayer, Edgar: Clinical Application of Sunlight and Artificial Radiation, Baltimore, Williams & Wilkins Company, 1926.

3. Hollender, A. R.: A Newer Concept of Infrared Radiation in Upper Respiratory Infections, Arch. Phys. Therapy **16**:150 (March) 1935.

in many sanatoriums for tuberculous and kindred diseases. For office and clinical practice one must resort for photochemical effects to artificial lamps, of which two types have been standardized: the carbon arc lamp and the quartz mercury vapor lamp. One need only think of the power of the ultraviolet rays to activate ergosterol and of their established clinical value in rachitis to appreciate the therapeutic possibilities of this powerful physical agency. As details would lead me beyond the scope of this paper, I must content myself with a sketchy survey of the therapeutic indications for ultraviolet irradiation in the domain of otolaryngology.

In otology ultraviolet irradiation has a place in selected cases of chronic otorrhea that has resisted accepted methods of treatment. Cemach,[4] in discussing the treatment of the middle ear with ultraviolet rays, stated: "Very often chronic suppurations dry up when treated endoaurally with the quartz pencil after having remained refractory to all other forms of treatment." Perhaps the most important rôle of ultraviolet irradiation is in the treatment of tuberculosis of the middle ear, for which it is a veritable specific. My own clinical results tally with those of Cemach, who has reported no less than fifty-six absolute cures in sixty-four cases. Lussmann and Bendove [5] likewise have reported a comparatively large group of cases of tuberculous otitis media successfully treated with this agency. Weinstein and Bendove [6] have reported not only similarly favorable findings but equally good results in nontuberculous infections of the middle ear. It hardly needs stressing that the tonic and stimulating qualities of the ultraviolet rays should be taken advantage of in the form of general irradiation of the body. This method of combined local and general irradiation is, of course, contraindicated in cases of coexisting pulmonary lesions during the febrile stage.

On the other hand, combined general and local irradiation decidedly is indicated to hasten resolution of protracted healing of mastoidectomy wounds.[7] Lupus of the auricle has been cured by the combined method of irradiation.[8] While it would seem that it should prove useful

4. Cemach, A. J.: Ultraviolet Therapy in Oto-Rhino-Laryngology, in Light and Heat in Therapy, London, The Actinic Press, Ltd., 1929.

5. Lussmann, F. J., and Bendove, R. A.: Chronic Otitis Media in the Tuberculous, Arch. Otolaryng. **6**:153 (June) 1927.

6. Weinstein, A. J., and Bendove, R. A.: Ultraviolet Treatment in Chronic Otitis Media in the Tuberculous, Arch. Phys. Therapy **15**:419 (July) 1934.

7. Hollender, A. R.: Postoperative Physical Aids in Otolaryngology, Arch. Phys. Therapy **12**:19 (July) 1931.

8. Sequeira, James: Carbon-Arc Light Baths in the Treatment of Lupus Vulgaris, Brit. J. Dermat. **35**:93 (March) 1923.

against a large group of cutaneous diseases of the auricle, palpable success has been observed only in cases of persistent chronic eczema,[9] even after failure with roentgen treatment.

Recently ultraviolet irradiation has been recognized as a remedy par excellence for erysipelas. My own experience has been identical with that reported by Ude and Platou,[10] Titus [11] and others, so far as it concerns this type of infection of the auricle and neighboring parts. All who appreciate the unreliability of the conventional measures advocated for the control of this treacherous form of infection will have to concede that in otolaryngologic practice, as in general surgical practice, ultraviolet irradiation represents an outstanding advance in therapy.

The bactericidal properties of ultraviolet rays are useful also for rhinologic conditions involving not only the outer skin but also the nasal mucosa. It was found that intense irradiation produced a destructive effect on tissue cells; its power, however, is exceedingly superficial. In this regard Strandberg's [12] contention that local irradiation is followed by a systemic response through absorption by the surrounding structures may be placed in the realm of conjecture.

While many workers have reported success in the treatment of nasal tuberculosis, especially lupus, there is no doubt that it is the combination of general bodily with topical irradiation that has much to do with the successful outcome.

There are now available apparatus which facilitate the irradiation of accessible cavities, such as the auditory canal and the nasal chamber. A so-called cold ray orificial unit enables one to subject the intranasal membranes to radiation, with varying reactions. While definite indications for the intranasal application of ultraviolet rays cannot be outlined at this time, it can no longer be denied that certain protracted infections which resist conventional therapy have responded favorably to irradiation.

Laryngeal tuberculosis is a disease for which physical therapy is a valuable aid. Phototherapy is regarded in the same place in its conservative, as cauterization in its radical, management. My own experience supports the opinion expressed by Plum [13] and others that curative

9. Hollender, A. R.: Scientific Status of Physical Therapy in Otology, Laryngoscope **45**:471 (June) 1935.

10. Ude, Walter H., and Platou, E. S.: Erysipelas: Comparative Study of the More Recent Methods of Treatment, J. A. M. A. **95**:1 (July 5) 1930.

11. Titus, Norman E.: Erysipelas—Treatment with Ultraviolet Light, Arch. Phys. Therapy **14**:722 (Dec.) 1933.

12. Strandberg, Ove: Heliotherapy and Artificial Light, J. A. M. A. **90**:1595 (May 19) 1928.

13. Plum, A.: Phototherapy of Tuberculosis of Larynx, Ugesk. f. læger **90**: 241 (March 15) 1928.

intervention must be deferred until a favorable immunologic state has been reached. If by that time phototherapy has not produced sufficient results to justify the conclusion that a cure by it may be attained at an early period, galvanocauterization is indicated.

While light therapy represents a distinct advance in the management of laryngeal tuberculosis, its application is an art which must be acquired to insure correct technic. In this condition, too, general irradiation should be avoided during febrile stages of the disease.

I cannot enter here into the theoretical aspects of light therapy of tuberculosis. For practical purposes one may regard the reactions following phototherapy as strongly akin to those observed after the injection of tuberculin.[14] Whether this concept is biologically correct or not is of little moment, the principal objective being a determination of the indications and contraindications of phototherapy on the principles governing the administration of tuberculin. I am wholeheartedly in accord with Cemach's statement that the results depend both on the resistance and on the reaction of the individual patient.

THERAPY WITH HIGH FREQUENCY CURRENT

A high frequency electric current is one with a tremendous number of alternations per second, which, when applied to an animal body with a properly carried out technic, results in the creation of heat within the tissues. This application of high frequency current for medical purposes has been popularized under the term diathermy. It differs from any of the previously described thermal methods in that with the latter heat is radiated from without and with only a superficial effect, while high frequency current produces conversive heat within the treated area, in which the epidermis itself may remain comparatively cool.

Diathermy is now available as the conventional long wave form and as the more recently introduced short wave form. From a purely clinical point of view, the difference between these two types of diathermy is that the newer one has all the therapeutic effects of conventional diathermy and the additional advantage of being applicable to acute suppurative processes.

When diathermy came in vogue in general medicine its striking effects naturally suggested an investigation of the indications for, and limitations of, its use in otolaryngologic practice. For this, empiricism had to be avoided, and clinical tests could be undertaken only after a scientific foundation had been obtained by experiments on animals.

14. Mayer, Edgar: Clinical Application of Sunlight and Artificial Radiation, Baltimore, William & Wilkins Company, 1926.

Ten years ago Cottle and I [15] experimentally demonstrated the superiority of diathermy over conductive heating; our findings have since been fully corroborated by other workers.

In otologic work we encountered some difficulties, partly because of lack of proper equipment and partly because we had first to solve the question of the most appropriate technic. It was precisely these handicaps which discouraged many workers, so that to this day the value of diathermy in otologic practice is still controversial. We found by experiments on animals, however, that diathermy applied by way of the canals of the ear does not adequately reach the middle or the inner ear. By applying a suitably shaped active electrode behind one external ear and a dispersive electrode anteriorly to the opposite ear we produced a pronounced rise of temperature in an area extending from the middle ear to the inner surface of the skull. We further established that the maximum temperature is reached with a current of from 300 to 500 milliamperes after about ten minutes, without in any way influencing the temperature of the brain or the general body temperature. The outcome of this experimental work was the definite establishment of the best method of approach, which is technically also the safest and least complicated one.

With these facts as a basis, Cottle and I [16] began a series of clinical tests in cases in which on theoretical grounds some benefit should be derived from active hyperemization of the deeper structures. In spite of persistent efforts we failed to produce any noteworthy therapeutic results, thus proving that thermotherapy is of no value for otosclerosis and nerve deafness. The only benefits derived from diathermic treatments were obtained in cases of so-called tubotympanic catarrh.

On the other hand, medical diathermy has proved a valuable adjuvant for the treatment of chronic disease of the nasal accessory sinuses.[17] By this I do not imply that surgical intervention is no longer needed, for in cases in which it is indicated it still holds its sovereignty uncontestedly, but even in cases in which surgical treatment is given preoperative and postoperative diathermy will often enhance the favorable course of the disease.

It is obvious that the frontal and maxillary sinuses are the ones most suitably located for diathermic treatment. The posterior sinuses,

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15. Hollender, A. R., and Cottle, M. H.: Diathermic Studies on the Eye and Ear, Arch. Otolaryng. **3**:438 (May) 1926.

16. Hollender, A. R., and Cottle, M. H.: Clinical and Experimental Studies with Some Physical Agents in Partial Deafness, Arch. Otolaryng. **3**:338 (April) 1926.

17. Hollender, A. R.: Conservative Management of Nasal Accessory Sinus Disease, Tri-State M. J. **3**:652 (Aug.) 1931.

owing to difficulty of access, are inadequately influenced by long wave diathermy. These anatomic handicaps may perhaps now be overcome by short wave diathermy. It is beyond my scope to detail the differences in the biologic effects on tissues and organic systems of the two types of diathermy, especially since a great deal about short wave diathermy is still in the experimental stage. It has, however, been established that with a proper technic short wave diathermy reaches deep structures unattainable with conventional diathermy. Accordingly, there is reason to believe that short wave diathermy will greatly enhance the therapeutic results in such conditions as ethmoid and sphenoid disease.

GALVANO-IONIZATION

The galvanic current is or should be known to every otologist, since it is one of the means with which to determine labyrinthine disease. Comparatively few otolaryngologists make use of the current for therapeutic purposes, though it is of decided clinical value through its electrolytic effects. Electrolysis should not be confounded with destructive procedures such as epilation of hair or devitalization of small neoplasms, because the same effect can be utilized also in a conservative or reparative sense.

By ionization [18] is understood the introduction or transfer of metallic or other ions into tissues through the galvanic current. As a firm advocate of the simplest possible measures, I have avoided complicated methods, so that in applying ionization to the ears and the nasal mucosa I make use of a solution of zinc sulfate as the electrolyte and of the simplest imaginable electrodes to "drive" the zinc ions electrically into the tissues. As my technic has been previously described,[19] I may restrict myself to a discussion of the therapeutic value of this method.

For more than ten years I [20] have used zinc ionization in cases of chronic suppurative otitis media, often with good results. In the contemporary literature one finds occasionally a negative assertion, but on close study it will be found that the fault is not with the method but with the manner of its application. I have stressed in publications the need for the electrolytic solution to reach the middle ear if the ionization treatment is to prove successful. Again, zinc ionization cannot be expected to accomplish more than certain local changes in

18. Leduc, Stéphane: Electric Ions and Their Use in Medicine, translated by R. W. MacKenna, London, Rebman, Ltd., 1908.

19. Friel, A. R.: Notes on Chronic Otorrhoea with Especial Reference to the Use of Zinc Ionization in the Treatment of Selected Cases, London, Simpkin Marshall, Ltd., 1929.

20. Hollender, A. R., and Cottle, M. H.: Newer Developments in Otolaryngologic Therapy, Arch. Phys. Therap. **8**:1 (Jan.) 1927.

pathologic structures. Naturally, in the presence of complications beyond the reach of the ionization, these too must be remedied; yet this elemental fact has been ignored and zinc ionization charged with failure.

I do not regard ionization as a panacea in aural sepsis. When, however, a rapid cure is not attainable by the usual methods, zinc ionization should be given a fair trial, and in many instances early cessation of any existing suppurative process will be observed.

Ionization has given satisfactory results in simple chronic rhinitis, in so-called intumescent rhinitis,[21] in nasal allergic conditions [22] and in certain types of sinus disease.[23] I have used it extensively in nasal allergy in the past few years and have devoted much research to establish its rationale. In spite of clinically satisfactory results, one should not speak of ionization as a cure, an interpretation permissible only after prolonged freedom from any disease. But even during the period of observation I have been gratified at the prolonged and complete symptomatic relief, something that I have failed to obtain with galenic and biologic preparations.

Zinc ionization produces a profound structural alteration of the nasal mucosa,[24] which accounts for the lessened hypersensitivity and susceptibility seen in allergic conditions. I have endeavored to correlate the clinical results in nonseasonal allergy with the histologic changes produced by ionization. In a series of studies undertaken at various stages before and following treatment I have demonstrated that zinc ionization produces an effect on the nasal mucous membrane having all the characteristics of fibrosis. Until it can be shown that other factors play a rôle in the symptomatic relief of nasal pathergy, one must accept the fibrotic change in the nasal mucosa as responsible for the success. True, there are other measures to produce histologic changes, such as cauterization by heat or caustics, but the changes produced by them are too destructive to be employed when there is a simpler, less harmful and more effective measure at one's disposal. Cauterization, to be sure, has given temporary relief, but there have been too many complaints made about its late effects. Sufficient time has elapsed to enable me to state that these disadvantages have not been experienced with ionization.

21. Hollender, A. R.: Physical Therapy in Hypertrophic Rhinitis, Illinois M. J. **64**:269 (Sept.) 1933.

22. Hollender, A. R.: Intranasal Zinc Ionization—Its Fundamental Aspects and Clinical Value, Arch. Phys. Therapy **15**:581 (Oct.) 1934.

23. Hollender, A. R., and Cottle, M. H.: Recent Advances in the Treatment of Nasal Accessory Sinus Disease, Eye, Ear, Nose & Throat Monthly **5**:575 (March) 1926.

24. Hollender, A. R.: Further Studies with Zinc Ionization in Nasal Allergy, Arch. Phys. Therapy **16**:360 (June) 1935.

ELECTROSURGERY

One may question whether the use of any of the high frequency currents for operative purposes should be grouped as physical therapy or as surgery pure and simple. Of course the removal of a neoplasm, for instance, is a surgical procedure, irrespective of whether it is accomplished by the scalpel and scissors, by actual cautery or galvanocautery or by a high frequency cutting or coagulating current. Yet the science of electrophysics has enriched surgery with a method of performing operations other than by classic dissection, justifying the inclusion of electrosurgical procedures in this presentation.

The same principles which govern the use of diathermy in general surgery apply with equal force to otolaryngologic surgery. The currents are utilized either to dissect tissues other than bones, similarly to surgical procedure with the scalpel, or to coagulate structures, which is a form of extirpation. Without regard for the histologic differences between wounds treated by classic and by those treated by electrosurgical methods, it must suffice to state that surgical diathermy seals the smaller blood vessels and lymph spaces during the operation. This suggests its preference in the eradication of malignant neoplastic disease.[25]

For extensive malignant growths and ulcerations in otolaryngologic practice, it has been found practicable to operate by first using the cutting current and then destroying every trace of the malignant cells in the spaces of the wound and searing off the surrounding structures to prevent reinvasion by the malignant process.

Benign tumors, too, may be advantageously extirpated by the high frequency current. I have operated for keloid of the auricle by this method and have not seen any recurrence, although this is common after surgical removal with the scalpel. Electrosurgical procedure is being utilized for the reduction of intumescent inferior turbinate bones, either in the form of electrodehydration or of submucous electrocoagulation.[26] Technics have been developed which render these procedures simple, safe and effective.

Superficial electrocoagulation promptly controls bleeding from septal ulcers.[27] This method promises to replace the galvanocautery in rhino-

25. Lederer, F. L.: Cancer of the Head and Neck: A Critical Analysis of Available Therapeutic Methods, Arch. Phys. Therapy **15**:517 (Sept.); 608 (Oct.) 1934.

26. Beck, Joseph C.: Pathology and Intramural Electrocoagulation of the Inferior Turbinate, Ann. Otol., Rhin. & Laryng. **39**:349 (June) 1930.

27. McKenzie, Dan: Diathermy Medical and Surgical in Otolaryngology, New York, The Macmillan Company, 1930.

logic practice because the undesirable carbonization of tissues seen after cauterization is avoided. Electrodissection of postoperative synechiae yields better results than are attainable by other methods. Needless to say, electrosurgical procedure is more advantageous also in the removal of intranasal growths, including polyps and granulomas.

The problem of the electrosurgical management of hypertrophied tonsils has lately aroused widespread discussion, pro and contra, as has no other problem in otolaryngology. Two opposing schools have come into being, the one upholding fractional electrocoagulation as a method of choice and the other utterly condemning it as a crude and unscientific operation. I have given this problem considerable study, weighing the advantages and disadvantages of tonsillar coagulation, and have reached conclusions [28] as to the rationale of this means of removing tonsils. Surgical tonsillectomy, in my opinion, is the method of choice in all cases except those in which there are decided contraindications to any operation. For this comparatively small group of patients tonsillar coagulation offers an acceptable substitute, which experience has shown to be preferable to irradiation with the roentgen rays or radium.

On the other hand, electrocoagulation should be the method of choice for the extirpation of tonsillar tags and stumps.[29] For lingual tonsils [30] a modified form of coagulation by needle punctures has proved useful, because it not only sterilizes but shrivels up the tissue without destroying it. The superiority of this form of reducing lingual tonsils becomes strikingly manifest through the absence of troublesome hemorrhage, so commonly encountered with the older methods of removal by the snare. Virtually every type of hypertrophied lymphoid structure in the pharynx has been successfully dealt with by electrosurgical procedure.

At one time electrocoagulation was advocated for the extirpation of laryngeal neoplasms, but it failed to come up to expectations, especially in cases of extensive and malignant growth. Laryngectomy is now the preferred operation for laryngeal cancer. However, for benign growths, such as papillomas, electrocoagulation, through the direct or occasionally the indirect approach, is fully adequate. Small lesions of the cords are especially suitable for fractional electrocoagulation, which ultimately produces complete eradication of the growth with a minimum of discomfort.

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28. Hollender, A. R.: Electrosurgical Tonsillectomy: Advantages and Limitations of the Fractional Electrocoagulation Method, Ann. Otol., Rhin. & Laryng. **41**:216 (March) 1932.

29. Hollender, A. R.: Electrosurgical Destruction of Recurrent Lymphoid Tissue After Tonsillectomy, Arch. Phys. Therapy **12**:600 (Nov.) 1930.

30. Hollender, A. R.: Hypertrophy of the Lingual Tonsil and Lymphoid Tissue of the Pharynx: Reduction by Electrocoagulation, Laryngoscope **42**:622 (Aug.) 1932.

Electrosurgical procedure represents a revolutionary method of therapy, especially in cases of malignant growth. But no matter how carefully and thoroughly it is performed, one must resort to the aid of the roentgen rays or radium to protect the treated and bordering fields against recurrence of the malignant process.[31] For so desperate a human affliction as cancer, it is, therefore, physical therapy in its widest sense that offers the best means of control.

CONCLUSIONS

Sufficient has been stated to show that physical therapy has a distinct place in otolaryngology. No claim is made that any physical procedure is a specific or a panacea. Physical therapy, is, however, a modern contribution to classic therapy to enhance clinical results and should, therefore, be more widely adopted in routine otolaryngologic practice.

SUMMARY

The duad of pharmacal and operative therapy has now been enlarged to a triad by the inclusion of physical therapy.

It is accepted as law that inflammation is a reactive process to infection and that by augmenting an existing hyperemia with thermic agencies one endeavors to overcome the underlying infection.

Phototherapy has been found of value in selected cases of chronic otorrhea, especially tuberculous otitis, lupus of the auricle and nose and erysipelas.

Phototherapy occupies the same place in the conservative management as the cautery holds in the radical management of laryngeal tuberculosis.

High frequency current, both long wave and short wave, is now available for deep heating of structures and for surgical procedures.

With proper technic, medical diathermy is superior to conductive heating of the auditory mechanism.

Medical diathermy is an effective aid in chronic nasal sinusitis both before and after surgical intervention.

Zinc ionization merits a thorough trial in chronic otorrhea; its efficacy in certain rhinologic conditions, notably allergic, is that of a decided and prolonged palliative.

Electrosurgery is a revolutionary method of dealing with benign and malignant conditions and often presents advantages over classic surgery.

Roentgenotherapy and radium therapy constitute parts of physical therapy of vital importance in combating malignant growths.

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31. Lederer, F. L.: Cancer of the Nasal Accessory Sinuses: Problems in Diagnosis and Management, Arch. Phys. Therapy **16**:199 (April) 1935.

BRUCELLOSIS IN OTOLARYNGOLOGY

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Brucellosis is a term recently applied to the clinical reactions to an infection with Brucella melitensis and Brucella abortus. It is a synonym of Malta or undulant fever but without the restrictions or disadvantages inherent in these names. Malta fever of the fulminating type, with high fever of undulating character, periods of apyrexia, profuse sweats, arthritis, myalgia and stomatitis, is now better classified as acute brucellosis. The ambulatory and intermittent forms, with the temperature normal in the morning or slightly elevated and a daily rise of from 1 to 3 F. and weakness, myalgia, malaise and particularly nervousness, can be considered as chronic brucellosis. Cases are now reported from every state in the union, Canada, the British Isles, Scandinavia, Germany, France and Austria. Etiologically, it follows the drinking of milk contaminated with Brucella or contact with infected cattle or domestic animals. Its incidence in infancy, childhood and adult life is apparently increasing, owing to the extensive and thorough search for the organism. It may be that the occurrence of the disease unrecognized in infancy and childhood is one of the causes for the relatively high immunity in adults.

HISTORICAL REVIEW

Evans,[1] Bierring[2] and Simpson[3] have published accounts on the development of the general knowledge of the disease which serve to clarify the nomenclature. An epitome of these is as follows: Bruce observed the organism causing Malta fever in 1887 and named it Micrococcus melitensis. The organism was noted shortly after to occur in bacillary forms. Bang recognized the bacterium causing contagious abortion in cattle as appearing in bacillary and coccoid forms in 1897 and called it Bacillus abortus. Evans in 1917 demonstrated that the

Read before the Section on Laryngology, Otology and Rhinology at the Joint Session of the American Medical Association and the Canadian Medical Association, Atlantic City, N. J., June 14, 1935.

1. Evans, A. C.: Chronic Brucellosis, Including a Discussion of Nomenclature, J. A. M. A. **103**:665 (Sept. 1) 1934.

2. Bierring, W. L.: Undulant Fever: Clinical Characteristics, Based on a Study of One Hundred and Fifty Cases Observed in Iowa, J. A. M. A. **93**:897 (Sept. 21) 1929.

3. Simpson, W. M.: Undulant Fever (Brucellosis), J. Indiana M. A. **27**:564 (Dec.) 1934.

organisms could not be differentiated by morphologic, cultural or biochemical methods and that serologically they were closely related. Meyer in 1920 proposed to identify the close kinship by calling them Br. melitensis and Br. abortus in honor of Bruce.

The otolaryngologic study of the disease has proceeded along three lines: impaired hearing, involvement of the pharynx and larynx and mimicry of other infections. Cantaloupe [4] in 1911 noted impairment of hearing in 20 per cent of all cases of brucellosis and observed the complication of acute otitis media, Videbech [5] in 1933 reported a case of nerve deafness, and Hirsch [6] in 1935 reported another case. Mohler and Traum [7] in 1911 demonstrated Brucella in the tonsils of children who drank raw milk. In 1924 Carpenter [8] showed that after feeding calves milk contaminated with Brucella the lymph glands draining the mouth and pharynx early became infected and were persistently enlarged. Carpenter and Boak [9] two years later observed the organism in eight pairs of tonsils in a series of fifty-five cases. No conclusions were drawn about the effect of the tonsillectomy on the length of illness. Fetterolf [10] in 1929 reported a case in which a tonsillectomy failed to elicit any cause for the fever. Four hours after the operation the patient had a chill, the temperature reached 105 F. and the leukocyte count was 17,000. Repeated physical examinations and all laboratory tests gave negative results until a positive agglutination with Brucella in 1:640 dilution solved the diagnostic puzzle. While the boy had no ill effects from the operation, the course of the disease was not shortened by it. Hirsch [11] in the same year reported two cases, one with subacute pharyngitis and the other with tonsillitis. In 1930 Natrop [12]

4. Cantaloupe, P.: Malta Fever in France: Clinical Study of Two Hundred Cases, Paris, Norbert Maloine, 1911, p. 69.

5. Videbech, H.: Auricular Affections Due Probably to Neuritis of Auditory Nerve: Case, Acta oto-laryng. **19**:87, 1933.

6. Hirsch, C.: Throat Infection with Bacillus Abortus: Two Cases, Ztschr. f. Hals-, Nasen- u. Ohrenh. **25**:256 (Jan. 25) 1930.

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observed three cases in which he considered the tonsils the portal of entry for the infection and noted that tonsillectomy did not shorten the illness. Malan [13] in 1931 reported extensive ulcerations of the tonsils, pharynx, epiglottis and larynx, in appearance closely resembling tuberculous lesions, with eventual complete recovery of the patient. The topical application of a 1 : 500 solution of acriflavine hydrochloride proved more efficacious in healing the ulcers than any other local treatment. Malan cited Fugoni as observing a similar case. Tarancon and Gutierrez [14] in 1932 reported a case with the complication of hoarseness due to sudden infiltration of the ventricular bands, the vocal cords and the arytenoid muscles. The lesion had the appearance of syphilitic infiltration. It rapidly progressed, with dysphonia, dysphagia and asphyxia severe enough to require tracheotomy. The patient eventually recovered, with slight hoarseness, under expectant treatment. Lieberheer [15] in 1933 reported pharyngeal or laryngeal complications in eleven of twenty-four cases, and Altrichter [16] in 1934 reported a case in which the condition simulated tonsillar sepsis. Instances of meningoencephalitis are being increasingly reported, but it seems the consensus that they are caused by infection in the blood stream rather than by the extension of aural or nasal infection.

Brucellosis does not cause a specific lesion of the ear, nose or throat. It is of interest to the otolaryngologist on account of the similarity of the lesions in the mucosa of the pharynx and larynx to those of tuberculous, syphilitic and pyogenic infections and also because of its capacity to simulate acute mastoiditis, thrombophlebitis of the lateral sinus, thrombophlebitis of the internal jugular vein and nasal sinusitis. The conclusion that acute mastoiditis, thrombophlebitis or sinusitis is the cause of fever is usually reached by a process of elimination. Influenza, pneumonia and pyelitis are excluded as a matter of routine. Tuberculosis, malaria and syphilis are likewise searched for on the slightest indication. To these I wish to add the consideration of brucellosis as another systemic infection, the recognition of which renders the differential diagnosis even more accurate and precise than it now is. The following four cases may serve as prototypes in illustrating a relation of brucellosis to otolaryngology.

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REPORT OF CASES

CASE 1.—J. D., a white boy, 4 years old, was ill for three weeks with fever. Physical examination of the heart, lungs and abdomen gave negative results, as did the urinalysis, the blood culture, the Widal test and the tuberculin test. The leukocyte count was 15,000, with relative lymphocytosis and secondary anemia. The temperature was 105 F. The patient had acute arthritis of the knees and elbows. Aural examination revealed a slight bulging of the tympanic membranes, which were translucent enough for one to see thick yellow pus in the middle ear. Ulcers were scattered over the buccal mucosa and lips. The condition was diagnosed as acute suppurative otitis media of the concomitant type and ulcerative stomatitis. The tympanic membranes were incised, and routine treatment was employed. The next morning the temperature was 99.4 F. and remained low for two days. The discharge from the ear was slight and thick. On the third day after the paracentesis the patient had a slight chill, the temperature rose to 105 F. followed by profuse sweating, the aural discharge was less, and the tympanic membranes again were incised. The temperature, while remaining elevated for two days, gradually fell to normal. On the third day following, the same condition recurred, except that the temperature rose to 106 F. unaccompanied by a chill. Repeated examination did not reveal edema of the walls of the posterior superior canal or over the mastoid process. The mastoid areas were neither painful nor tender. It was suspected, of course, that an erysipelatous type of streptococcus might be the invading organism, with its virulence increasing as it advanced across the mastoid and involved the lateral sinus. The acute suppurative otitis media, the polyarthritis, the blood count and the septic type of temperature suggested atypical mastoiditis with thrombophlebitis of the lateral sinus. On the other hand, the child had been ill for three weeks, the course of the fever had been the same from the onset, the acute otitis media was of the concomitant type, which occurs as the result of systemic infection and rarely as a focus of infection, the physical signs of acute mastoiditis could not be demonstrated, and the temperature, while septic, differed from that observed in thrombophlebitis by not conforming either to the wide daily sweeps of the septic, the pneumonic or the typhoid type but being undulant. Clinically, the picture was that of brucellosis, and this opinion was confirmed by a positive agglutination with Br. abortus in a dilution of 1:640.

CASE 2.—Mrs. O. D., a white woman aged 34, gave a history of fever and cough extending over a period of eight months. There was a daily rise of temperature to about 101 F., with some loss of weight and strength. A headache over the frontal or temporal region was a daily occurrence. Expectoration was slight. The patient was referred to me for examination of the nasal sinuses, and my opinion was that acute or chronic sinusitis was not present. A diagnosis of chronic pulmonary tuberculosis was made later, and the patient went to a sanatorium for three months. Examinations of the sputum for Bacillus tuberculosis gave repeatedly negative results. Later she was advised that the pulmonary condition was bronchiectasis and that this, the cough and the fever were due to chronic sinusitis. She returned to me nine months after her first visit with pansinusitis following a cold. After complete recovery from acute suppurative sinusitis, a positive agglutination with Br. melitensis was demonstrated in a titer of 1:800. The clinical lead in this case was an ambulatory patient with fever for eighteen months, excellent nutrition, no definite lesion in the chest, no B. tuberculosis in the sputum and a normal condition of the nose.

CASE 3.—Mrs. H. A. T., a white woman aged 23, had a fever and headache for three months and had considered it "sinus disease," notwithstanding the

absence of colds or nasal discharge. Besides other treatment, she spent four weeks in a hospital taking a rest cure for nervousness and weakness. Examination of the nose and throat gave negative results. Positive agglutination with Br. melitensis was demonstrated in a titer of 1 : 800.

Case 4.—This case was particularly interesting because of the difficulty in eliminating the diagnosis of thrombophlebitis of the internal jugular vein. Mrs. F. A. C., a white woman aged 42, had the onset four days before examination, with sore throat and fever. The knees and calves became tender and painful on the second day. Examination revealed a few small buccal ulcers and hyperemic tonsils slightly enlarged, with the familiar appearance of a subacute infection. The temperature was 101 F. While the febrile reaction was recognized as disproportionately high for the physical findings in the tonsils, nevertheless the patient was treated for acute tonsillitis. On the seventh day of the illness she had a chilly sensation; the temperature reached 103.8 F., followed by sweating; the condition of the tonsils was unchanged, and the arthritis and myositis became more annoying. The leukocyte count was 11,000, with an increase in the percentage of lymphocytes. The tonsillitis at this time was clearly not the cause of the fever, and the possibility of thrombophlebitis of the internal jugular vein had to be considered. The evidence in favor of thrombophlebitis was the history of sore throat, the septic type of temperature, chilly sensations, sweating, polyarthritis and myositis. On the other hand, the ulcerative stomatitis, the arthritis and myositis on the second day of the disease and the slight leukocytosis with relative lymphocytosis raised the question of systemic infection rather than of a tonsillar sepsis. Blood cultures gave negative results, but later a positive agglutination was obtained with Br. abortus in a 1 : 640 dilution.

While the diagnosis of brucellosis was merely the beginning of another story for each of these patients, it completely excluded the further consideration of the ears, nose and throat as the cause of sepsis. The first case is illustrative of a group with acute suppurative otitis media in that diagnostic moiety of acute mastoiditis, thrombophlebitis and pyelitis indicated some systemic infection as the cause of fever. In such cases definitive and efficient treatment is utterly dependent on the accuracy of the diagnosis. The diagnostic study of atypical acute mastoiditis can hardly be said to be complete without consideration of brucellosis. Only occasionally will the tests give positive results; but when that occurs it may be life-saving, as it probably was in case 1. Case 2 indicates that physicians in increasing numbers are considering nasal sinusitis as a cause not only of headache but also of fever of obscure origin. Their surmises prove to be correct in most instances. Case 3 shows how this information has permeated to the laity.

DIAGNOSIS

A diagnosis of brucellosis is uncertain by clinical methods unsupported by laboratory tests. While the laboratory technic is not of direct concern to the otolaryngologist, acquaintance with the various methods is advisable in order to appraise their relative value in diagnosis. The methods of definite value are cultural, serologic and allergic. The iden-

tification of Brucella in cultures of the blood or excreta requires specialized technic and proves the diagnosis, but a negative result is of little significance. Positive agglutination in high dilution is usually considered to establish the diagnosis, though it may be in error on account of a previous infection or the patient's contact with an infected animal. Negative agglutination is not so accurate. Yeckel and Chapman [17] stated that the optimum time to read the results of the cutaneous test is on the fourth day, or ninety-six hours after the intradermal injection. The true positive reaction begins to appear on the third day, and on the fourth it is about 5 cm. in diameter. The positive cutaneous reaction means not so much a present or past infection as a sensitization to Brucella. Huddleson and his associates [18] have developed a technic for determining the opsonocytophagic power of the blood for Brucella. They proposed to use this in conjunction with the test for agglutination and the cutaneous test to increase the accuracy in diagnosis.

CONCLUSION

The otolaryngologist comes in contact with the complications of brucellosis as well as with the systemic infection. Nerve deafness may occur, as with other infections. The complication of mucosal lesions of the pharynx and larynx may resemble those of tuberculosis and syphilis. The systemic infection occasionally simulates some aspect of pyogenic infection of the ear, nose and throat. Only rarely will the need even of considering brucellosis arise except in patients with fever of uncertain origin and in atypical cases.

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ABSTRACT OF DISCUSSION

Dr. Redvers Thompson, Ste. Anne de Bellevue, Canada: Dr. Cody's observation opens a new field for investigation. One, however, should clearly distinguish between localized lesions due to Brucella and those due to intercurrent streptococcic infections.

During the cultural investigations on brucellosis I have not readily succeeded in isolating Brucella from localized abscesses, although cultures of the blood of my patients were persistently positive. The localized abscesses have generally shown streptococci or staphylococci. When examining mllk, I could consistently isolate Brucella until mastitis intervened. The technic of isolating Brucella is highly specialized. Brucella of bovine origin requires a special culture medium and also special atmospheric conditions. It is by these cultural methods that the information finally desired will be gained.

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17. Yeckel, H. C., and Chapman, O. D.: Brucella (Alcaligenes) Infections in Man: Intradermal Reaction as Aid in Diagnosis, J. A. M. A. **100**:1855 (June 10) 1933.

18. Huddleson, I. F.; Johnson, H. W., and Hamann, E. E.: Study of Opsono-Cytophagic Power of Blood and Allergic Skin Reaction in Brucella Infection and Immunity in Man, Am. J. Pub. Health **23**:917 (Sept.) 1933.

I have attempted to culture Brucella in clinical cases of undulant fever in Quebec. I have used a culture medium containing pressure extracts of tissues. These were extracted at a pressure of 5,000 pounds (2,500 Kg.) per square inch (2.5 sq. cm.) and were passed through Berkefeld filters and added to the culture medium.

The isolation technic was carried out by the spun tube method. I have devised a machine for preparing the spun tubes. The machine consists of a cone mounted on a vertical shaft. The cone is inside a water jacket filled with water. When the machine is stationary the tube containing the liquefied culture medium floats free from the cup. When the machine is set in motion the disturbance set up in the water makes the tube sink. At 1,500 revolutions the tube connects with the spinning cone and is made to spin. The centrifugal force causes the medium to spread over the walls of the spinning tube to form a solidified film, gradually diminishing in thickness toward the upper limit.

In spreading the inoculum in these prepared tubes, I add the inoculum to the base of the tube and spin it at a speed of 1,900 revolutions; as it is spun the inoculum climbs up the walls and is distributed over the surface.

The bacteriologic observations show that of the twenty-three cases studied blood cultures gave positive results in seven; the suspected milk produced a positive reaction in sixteen of twenty-one cases in which the test was made. All the patients used raw milk. Approximately 20 per cent of dairy herds in Canada are infected with Brucella. With one exception every organism isolated required an increased carbon dioxide content, indicating that the organisms were of the abortus variety.

Dr. Walter M. Simpson, Dayton, Ohio: During a study of one hundred and forty-eight cases of brucellosis encountered in and about Dayton, I have noted many instances in which localized manifestations of the disease simulated lesions due to streptococci or other organisms. Abdominal pain was a prominent feature of the disease in eighteen cases. In five cases the pain was most marked in the right lower quadrant; in four appendectomy was performed. The appendix was normal in three. Gangrenous appendicitis occurred during the third week of illness in one case; this was regarded as pure coincidence. In one case, cholecystectomy was contemplated because of the development of pain in the right quadrant, associated with fever, chills and sweats. I have heard about thirty instances in which appendectomy or cholecystectomy has been performed on a patient with undulant fever in whom the pathologic examination revealed no evidence of an active inflammatory process in the appendix or gallbladder. I have encountered four cases of suppurative prostatitis, epididymitis or orchitis as a complication of brucellosis. In one case Brucella was recovered in pure culture from a sinus tract which developed between the epididymis and the scrotal wall.

I should like to interject a word of caution with regard to the establishment of a diagnosis of brucellosis on the basis of the agglutination test alone. Many persons who have had the disease several months or years previously have a persistence of agglutinins in the blood serum. If such a person acquires an infection, and the blood is taken for the agglutination test for undulant fever, it is likely that a positive agglutination reaction, usually in low titer, will be observed, merely as a remnant of the previous infection. Therefore, the agglutination test alone is not sufficient unless all the clinical manifestations of the disease have been observed and cultural studies and the cutaneous test have been carried out. In such cases one usually finds agglutination titers below 1: 100, and it is in that group that particular caution should be exercised.

I have utilized a Br. melitensis (abortus) vaccine in treatment in seventy-two of the one hundred and forty-eight cases of brucellosis which we have studied. A comparison with the results in seventy-six cases in which the vaccine was not used gave unmistakable evidence that the vaccine usually terminates or shortens the course of the disease and prevents recurrence. Favorable clinical response to vaccine therapy occurred in 90 per cent of the patients treated with vaccine. The vaccine has been approved by the Council on Pharmacy and Chemistry of the American Medical Association and is now available through the usual trade sources. I have observed that intravenous injections of mercurochrome, acriflavine hydrochloride, neoarsphenamine and typhoid-paratyphoid vaccine do not exert a favorable influence on the course of the disease. The severe reactions which followed the intravenous administration of mercurochrome in three patients alarmed me to such an extent that I have not administered mercurochrome intravenously for any purpose since that time.

Much more important than the treatment of the disease after it occurs is its prevention. The chief source of brucellosis is the raw milk obtained from infected cattle. Adequate pasteurization destroys Brucella as well as the many other disease-producing organisms commonly found in raw milk. To those who are still opposed to pasteurization, the widespread occurrence of brucellosis in this country should provide a convincing and, it is to be hoped, a final argument in favor of universal pasteurization of milk and other dairy products.

Dr. Caesar Hirsch, New York: It was very interesting to learn that brucellosis simulates acute mastoiditis, thrombophlebitis of the lateral sinus or jugular vein and sinusitis. In my cases and in cases reported by others there was no involvement of the middle ear but impairment of hearing as well as of equilibrium, probably due to neuritis of the auditory nerve.

It may perhaps be assumed that brucellosis may lead to circumscribed meningitis, with inflammation of the auditory nerve, like parotitis. Both parotitis and brucellosis not infrequently produce orchitis.

Brucellosis in otolaryngologic practice is still in its infancy, but the interest of the medical profession will be awakened by Dr. Cody's paper, and soon more will be known about the disease.

Dr. Claude C. Cody, Houston, Tex.: The cases that I have reported were not so much examples of infection of the ear, nose and throat as of mimicry of the pyogenic infections of these areas. In the first case cited it was clear that the mastoid was not infected. It is doubtful that there is a place in otolaryngologic practice for brucellosis, although otolaryngologists will come in contact with it until the general practitioners become more conversant with its symptoms and widespread distribution.

RHINITIS CASEOSA

ANALYSIS OF THE LITERATURE AND REPORT OF A CASE

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Rhinitis caseosa is a rare type of unilateral nasal disease characterized by the accumulation in the nose and sinuses of an extremely offensive, cheeselike mass, by the presence of a seropurulent discharge and other manifestations of chronic suppurative sinusitis and last by intranasal and frequently by extranasal deformity. The term rhinitis caseosa was conceived by Duplay in 1874. It was his opinion, based on experience with two cases and on a paper by Maisonneuve in 1855, that facial erysipelas precedes the development of rhinitis caseosa. The erysipelas involves the nasal mucosa by extension, whence epithelial exfoliations and the retention of the exfoliated débris result in the formation of the characteristic foul, cheeselike mass, which Duplay considered to be "analogous to the contents of certain sebaceous cysts."

Subsequent authors found no quarrel with Duplay's classic description of the endonasal picture and postoperative course of this disease, as displayed faithfully by our patient. The differences of opinion formed about the pathogenesis; and since the condition was so rarely encountered, most of the authors lacked sufficient personal experience to speak from any source other than conjecture and the perusal of a limited bibliography. Duplay's theory of erysipelas was quickly challenged the following year by D'Azambuja, who reported a case which occurred subsequent to influenza, and by a host of others, each of whom offered a modus operandi more to his own liking.

Thus there developed a number of theories on the pathogenesis of rhinitis caseosa, each with its set of enthusiasts, as follows: (*a*) The "nasal erysipelas" theory of Duplay was supported by Kirmisson, Nélaton, Jamain and Terrier and others but was quickly discarded. (*b*) The "scrofulas diathesis" theory of Cozzolino was taken up at intervals but

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Read before the Otolaryngological Section of the Medical Society, County of Kings, Nov. 13, 1935.

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was rejected generally for lack of evidence, even though Cozzolino's communication to the French surgical conference in 1889 stated that Italian specialists had found an organism resembling the tubercle bacillus. (*c*) The "disease entity" theory was championed by Guarnaccia, Martuscelli, Gavello and Leith and Lewis, each of whom was satisfied that Streptothrix alba was the causative organism. Masini, writing in 1900, expressed the opinion that rhinitis caseosa exhibited "too decisive a clinical personality not to be motivated by a specific, but as yet undetermined micro-organism." (*d*) The "nasal cholesteatoma" theory was advanced by Tillaux, Wagnier, Bruzzone and Otrich. Cozzolino is included in the group also, as he fathered the idea of cholesteatoma on the additional assumption that the process would occur only in scrofulous persons. None of these observers noted concentric lamellae, a diseased matrix, or any other diagnostic feature of cholesteatoma, and Kelson provided excellent evidence against the acceptance of the theory in 1904 by his microscopic studies on tissues taken from the wall of the cavity remaining after the removal of a cheesy mass. He observed the unchanged nasal columnar epithelium, surely not the kind that lends itself to the formation of cholesteatoma. (*e*) The "foreign body" theory satisfied Hill, Molinié, Klingel, Grant, Daley and Hopmann. Hill observed ten cases in thirty years of active practice and expressed the opinion that some form of foreign body (which later included polyps and other blocking growths) was the irritating factor. (*f*) The "necrobiosis of polyps" theory was propounded by Bories and Schleicher. These investigators expressed the opinion after microscopic studies of limited scope that a necrobiotic change in one or several polyps produced the putty-like mass. (*g*) The predominantly accepted explanation, having by far the greatest number of adherents, is that rhinitis caseosa is a secondary condition symptomatic of an underlying, primary nasal abnormality, like sinusitis, polyps, neoplasm, septal deflections or other stenosing conditions which tend to interfere with the egress of discharge from the nose. Of this group, which includes Potiquet, Mandroux, Strazza, Dasque, Calamida, Cartaz, De Rosa, Kelson, Edmunds, Gesheilin, McKenzie and many others, Arslan seems to have had considerable experience, having observed seven cases, in all of which he noted a chronic suppurative antritis and a blocking feature to trap the discharge. Therefore, he concluded in the last of four papers on the subject that rhinitis caseosa is always secondary to chronic suppurative sinusitis and stagnation. Calamida observed eight cases in Gradenigo's clinic, and his report in 1906 substantiated the conclusions of Arslan. Dr. Brown Kelly in 1919, while discussing McKenzie's paper, claimed to have observed a dozen cases, from which he concluded that "Rhinitis caseosa is not a morbid entity but the term

suitable for a condition in which, owing to mechanical causes, the secretion is bottled up, stagnates, and undergoes physical and chemical changes." Martuscelli compromised with several schools of thought by an interesting classification in which he stated that rhinitis caseosa vera was the type initiated by a specific micro-organism, while rhinitis pseudocaseosa was the form seen as a consequence of blocking polyps, sinusitis, foreign bodies, etc. Authors continued to elaborate on the nonspecific idea. Calamida agreed with Duplay that the stagnating mass acted as an irritant and stimulated continuous exfoliation, thereby increasing the bulk of the accumulation. McKenzie explained the bony losses by favoring the idea of chemical dissolution rather than mechanical pressure. And Gesheilin, in his excellent article, expressed the opinion that the final factor is a putrefactive organism which completes the morbidity after the effects of sinusitis, stagnation and dehydration have produced the ground work. Other less popular theories were advanced, but none of the authors of approximately seventy-five articles, comprising a bibliography of all the available literature on the subject, advanced sufficient scientific data and evidences of experience to substantiate conclusively one explanation to the exclusion of the others.

From an analysis of the material gathered in this exhaustive search into the literature, we present the following information:

Synonyms: Other names for the condition are coryza caseosa, ozena caseosa, rhinitis cholesteatomatosa and caseous purulent rhinorrhea.

Involvement: The condition is invariably unilateral and occurs as frequently on one side as on the other.

Sex: Of approximately one hundred cases reported, 43 per cent were in females and 57 per cent in males.

Age: The youngest patient was 9 years old and the oldest 80. The greater number of patients were in the third and fourth decades of life.

Locality: Most of the patients were French and Italian, a minority were English and German. Scattered cases were reported from Russia, Poland, Hungary and Brazil, and one from America, which Otrich reported in 1925 under the title "Cholesteatoma Involving the Ethmoidal Cells and the Antrum of Highmore."

Symptoms and Signs: The clinical picture usually develops by progressive stages. (*a*) The early stage is a period of unilateral (or bilateral) nasal discharge and other indications of chronic suppurative sinusitis. Rhinoscopic examination usually reveals the ordinary signs of sinusitis plus polypi, occasionally the presence of a foreign body (rhinoliths, buttons, beads, blotting paper and, in Abercrombie's unusual case, a canine tooth that had erupted into the inferior meatus) and not infrequently the early formation of foul cheeselike particles.

(*b*) In the later stage the discharge is profuse and extremely offensive to both the patient and the outsider, one or both sides of the nose are completely obstructed, and not infrequently the patient complains of tearing, burning of the eyes or some other ocular discomfort. Rhinoscopic examination reveals granulations, polyps, profuse seropurulent discharge, the characteristic malodorous cheesy mass and intranasal deformity, the turbinate bones, ethmoid labyrinth and naso-antral wall being eroded or completely destroyed, while the septum appears to be pushed bodily toward the opposite side. The ocular complaints are based on the presence of conjunctivitis, dacrocystitis or some similar abnormality.

(*c*) The ultimate stage is reached in badly neglected cases and is characterized symptomatically by the appearance of facial disfigurement, discharging bony fistulas and a run-down state as a consequence of loss of appetite and sleep. On examination the facial disfigurement is seen to be caused by swelling of the cheek and widening of the bridge of the nose, but there may also be present a displacement of the eyeball forward and laterally and a fistulous tract established in the canine fossa or the frontal process of the superior maxilla. Intranasal inspection may reveal marked bony destruction of the nasal septum, the hard palate and the lateronasal osseous structures, the cheesy mass completely filling the distorted interior, discharging pus and cheesy crumbs through all possible channels. The patient exhibits unmistakable evidence of moderate debility.

Diagnosis: The most frequent mistake in diagnosis is considering the condition to be malignant, especially after it has gone into the late stage; however, the cheesy, very foul débris, which is easily spooned out with very little bleeding, leaving a rather clean cavity that goes on to uneventful healing, differentiates rhinitis caseosa from nasal sarcoma. Occasionally ozena is the incorrect diagnosis, but since caseous rhinitis is unilateral and clears up promptly by the removal of the débris, the two conditions should be easily differentiated.

Pathologic Observations: The cheesy part is an amorphous mass, the polyps are frequently necrobiotic, a great variety of unrelated fungi and micro-organisms are reported (S. alba deserves special mention), and the results of chemical studies are hopelessly contradictory and seemingly inconsequential.

Prognosis: The prognosis is excellent. The complete removal of the cheesy débris and routine after-care result in a healthy, though overlarge, nasal cavity, with complete amelioration of symptoms. Bony fistulas tend to fill in promptly.

Treatment: Thorough removal of all débris and then daily sprays and irrigations are sufficient.

REPORT OF CASE

Yolanda P., an 8 year old American born girl of Italian descent, was admitted to the ward on April 29, 1935, with the following complaints: (1) offensive odor and discharge from the nose for the past two years; (2) nasal obstruction on the right for the past six months, and (3) swelling of the right side of the nose and face during the past two months.

The family history was negative; the father, mother, four sisters and two brothers were living and well. No evidence of familial tuberculosis, syphilis, cancer or diabetes was elicited. The patient had had four sieges of pneumonia at various intervals and measles several years before, and the tonsils and adenoids were removed six months prior to admission. She adopted a dull, listless attitude, was backward in her school work and ate and slept poorly.

The present illness began two years previously, when following a severe cold in the head, an offensive nasal discharge persisted, especially from the right naris, and became increasingly troublesome. About six months prior to examination, the nasal

The patient at the time she was admitted to the hospital.

obstruction became bilateral; it was uninfluenced by tonsillectomy and adenoidectomy, and shortly thereafter, the family of the patient noticed a slowly advancing swelling of the right side of the face and the bridge of the nose. This had continued to the time of admission.

Examination revealed an obvious disfigurement of the child's physiognomy. The bridge of the nose, especially on the right side, appeared to be fuller and broader than normal, and the entire right side of the face seemed enlarged, producing an apparent facial asymmetry. Tenderness was elicited over the right malar area and in the right canine fossa, the wall of which was definitely advanced. A very offensive odor emanated from the nares, of sufficient pungency to be perceivable throughout the ward. The skin of the nares was excoriated.

Rhinoscopic examination revealed a profuse, extremely foul, grayish discharge, containing cheeselike particles. After the discharge was suctioned off, a plastic mass was observed in the right side, putty-like in color and consistency, which filled not only all the available nasal space but also areas normally containing the anterior ethmoid cells, the naso-antral wall, the middle turbinate bone and the antrum. This was determined by passing a probe through the soft mass and noting

the deficiency of the structures. Surrounding the mass superiorly, laterally and anteriorly, there was a grapelike fringe of polypoid tissue, the anterior segment of which was attached to the region of the agger nasi.

The left side of the nose was crowded by a general septal deviation and was diffusely congested, but it was normal otherwise. The pharynx, ears and neck were normal, and the results of a general physical examination, other than the signs of a moderate degree of malnutrition, were essentially negative.

During the period of observation which followed, we collected the following data: A culture of the nasal discharge yielded the fusiform bacillus and the spirillum of Vincent, the Wassermann reaction of the blood was negative, and the temperature, pulse and respiration curves were normal. Roentgenograms of the sinuses showed a widened and completely opaque antrum on the right side, an enlarged nasal space on the right, which was obstructed by an irregular mass of changing density, and a marked general deviation of the septum to the left.

Following this investigation, the child was taken to the operating room, and, with the patient under general anesthesia, all the cheeselike material filling the right nasal spaces was removed with curets until a large cone-shaped cheesy cast was picked out of the antrum. Several polyps were removed from the ethmoid region and the middle meatus, and the necrotic remains of the ethmoid cells and the naso-antral wall were removed. After thorough removal of all the cheesy débris, an overlarge nasal cavity on the right was seen, caused by the loss of turbinate, ethmoid and naso-antral bony substance, but also partially due to the general swing of the septum to the left. However, the mucosal lining of the enlarged interior looked surprisingly healthy. Iodoform gauze drains were inserted, and the patient was returned to the ward.

The pathologist examined an irregular, pinkish, friable mass of tissue removed at operation, and under the microscope observed it to be relatively cellular but of indistinct character due to degeneration, the diagnosis being necrotic tissue. A smear taken at operation contained fusiform bacilli and spirillae in predominance.

The postoperative course was uneventful. The foul discharge from the nares ceased, nasal breathing was reestablished, the patient appeared brighter and the appetite was improved. After-care consisted of daily sprays and irrigations. The child was discharged on May 21 in good health, with some improvement in the asymmetry of the face.

COMMENT

We offer no new information on the subject of rhinitis caseosa but join hesitantly the large group that believes the condition to be an occasional offshoot of chronic suppurative sinusitis. We place no great stress on the finding of Vincent's organism, just as we think that Guarnaccia and his disciples, with their limited experiences, could not point with scientific assurance to the presence of Streptothrix alba, Payton to the presence of Bacillus xerosis and Streptococcus hemolyticus II or Taptas to the presence of Bacillus diphtheriae. We disagree with the illogical conclusion of Bruzzone (in spite of his extensive experience with eighteen cases) that the condition is cholesteatoma of the sinuses and nose since none of the criteria required for this diagnosis were advanced. The "erysipelas" explanation of Duplay and the "scrofulous diathesis" theory of Cozzolino have fallen quickly for sheer lack of

clinical support. Edmund's attempt to compare the process with that observed in cases of cholecystitis is interesting but unsubstantiated. Beausoleil answered the theory of necrobiosis of Bories by submitting evidence that this pathologic change is common in polyps, most of which are unaccompanied by cheesy formations.

So, by process of elimination, we accept temporarily the popular belief that some physicochemical change in stagnating nasal secretion, produced as a consequence of chronic sinusitis, is the most satisfactory explanation of rhinitis caseosa. However, Masini's forceful point of view "that the disease has too decisive a clinical personality not to be motivated by a specific, but as yet, undetermined micro-organism" continues to intrigue us with its logic.

Finally, we have attempted to crystallize all past information on the subject into one inclusive presentation. As far as we know, American medical literature is devoid of an article on the subject. We hope by this paper to arouse general interest and to stimulate in the future a thorough investigation into and report of each case of rhinitis caseosa.

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SURGICAL REPAIR OF THE FACIAL NERVE

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Surgical procedure on the mastoid is beset by the possibility of unpleasant sequelae, one of which, facial paralysis, I shall discuss. It is the most distressing nonfatal surgical catastrophe, because it is evident to the patient's associates as well as to the sufferer himself. Various procedures aimed at anatomic and functional restoration have been suggested. They are: direct anastomosis (Bunnell [1] and Martin [2]), apposition of the ends without suturing (Graham [3]), interposition of a homogenous nerve graft (Ballance and Duel [4]) and simple decompression of depressed fractures of the canal (Smith [5]).

My associates and I have employed the first three of the aforementioned methods successfully in three cases. Other patients are under observation, but insufficient time has elapsed to determine the result or to justify predictions. The use of a homogenous graft, which has been allowed to degenerate in situ before it is removed, to bridge the gap in the facial nerve (Duel) promises results, but we have had no opportunity to employ it.

The cause of injury is of interest since future injuries may be prevented by its record. In two cases the damage probably resulted from searching for the antrum at a point too far caudad. The track of a fine curet was noted to and through the nerve at a point just below the horizontal canal in one case. In another case at a similar point a sweep of the curet had laid bare and injured the nerve for a distance of 0.5 cm. In a third patient, on whom operation had recently been performed, a curet had similarly been directed at too low a point, and its track

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Read before the California State Medical Society, Yosemite, Calif., May 16, 1935.

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transected the canal and emerged under the skin of the external canal. In a fourth patient, on whom a second operation had not been done, the nerve was laid bare and lightly contused in clearing out the retrofacial cells. This patient is recovering after decompression and laying together of the fibers which were severed. All the aforementioned injuries occurred in cases of so-called simple mastoidectomy. In two patients the middle ear was injured by a competent surgeon in performing radical mastoidectomy. One of these had had curettage for the relief of an extensive cholesteatoma, during which procedure the nerve was removed for 3 or 4 mm. The second patient had had several plastic operations for repair of severe trauma of the external and middle ear. A cholesteatoma had developed behind the strictures in the canal and had altered the landmarks considerably. During the removal of this mass the nerve was severed in the middle ear. The reparative efforts on this patient cannot be reported as yet.

Injury to the nerve in the middle ear is the most difficult to repair because of the limited space in which to place the anchoring sutures for the graft or for the apposing ends, when they can be brought together.

All these patients had marked facial paralysis on recovery from the anesthesia. There is a group of cases in which the palsy appears hours or days later. This seems to be the result of neuritis due to edema or to the pressure of packing too tightly applied. We have had one such case in which the condition followed our own surgical procedure and have observed five other patients in consultation. In one of these five cases, twitching of the nerve occurred during operation, which indicates trauma and accounts for the slow recovery of three months. In all the other cases the palsy cleared in from five to ten days.

The pathologic changes in the last group seem to me similar to those occurring during an attack of acute otitis media. On two such patients, in whom the weakness of the facial muscles appeared about the fourth day of fulminating otitis, no operation was performed. There was early tenderness over the mastoid, which cleared rapidly. The weakness of the facial muscles cleared in about a month. A third patient with similar weakness and tenderness over the mastoid, appearing two weeks after the onset of the otitis, was operated on with recovery of the function of the facial nerve in four days. We were guided entirely by the indications for mastoidectomy in each case. The nerve was not decompressed in the last case, an operation which has been suggested by others, and experience in this instance suggests that such a procedure is not necessary, though it is obviously too limited to permit this conclusion to be accepted as final. The patients were all young adults.

When injury to the nerve is evident postoperatively, the problem arises as to when to operate. Two factors must be considered. The

first is that of asepsis or avirulence of the causal organism. It seems to us best to wait until a clean field, or at least a field with avirulent organisms, is obtained. This has been our procedure. The second factor relates to the danger of sagging muscles, resulting from the longer time elapsing before recovery when the first factor is considered. As the first factor has been complied with in all the present cases, the results cannot be compared, but the patients have recovered without noticeable asymmetry of the face. Another reason for waiting is that many patients recover spontaneously in from six to eight months. The surgeons who performed the original operation in the present cases did not know that they had injured the nerve at the time of operation. In any case in which this is known the earliest possible operation, the first factor being borne in mind, is advisable; nothing is gained by awaiting an impossible spontaneous recovery.

The table shows in the three cases the time between the operations, the type of operation and the time required for recovery of tone and motion.

Time of Operation in Relation to Recovery

Time Between Operations	Type of Operation	Period of Recovery of Tone	Period of Recovery of Motion
12 mo.	End-to-end anastomosis	7 mo.	Began in 8 mo.; good in 14 mo.
41 days	Decompression and neurolysis	41 days	3 mo.
7 mo.	Homogenous graft	9 mo.	Began in 11 mo.; good in 14 mo.

The care of the patient awaiting secondary operation is important. Support of the muscles by strapping is essential if a hopelessly elongated musculature is not to result. Anxious as the patient is to obtain a good final result, it is difficult to have him attend to this. The strapping of adhesive tape should run from the corner of the mouth to a position far lateral on the forehead.

As to electrical treatment Royle [6] stated:

> The faradic current should be mentioned only to be condemned, since it has no effect on denervated muscles; and when muscles have recovered, active movement is the most appropriate treatment. The galvanic current has no effect on the rate of recovery of nerves, and active movements return to the face long before faradic stimulation is possible. To apply electric stimulation to the face in any stage is a waste of time and money.

In this connection Royle suggested that the weak facial movements after injury of the facial nerve are caused by the altered length of the muscles, and he expressed the belief that vigorous handling by massage

6. Royle, N. D.: The Conservative Treatment of Facial Paralysis, M. J. Australia **2**:385 (Sept. 22) 1934.

may be a factor in producing such lengthening. Such massage as is given should be directed toward reducing edema in the canal (he was referring to treatment for Bell's palsy) and should be applied to the area over the mastoid and the side of the neck from the occiput to the chin on the affected side.

After operation the patient presents the same problem of support and massage. The latter procedure should never be permitted near the auricle, as traction conceivably might spoil the sutured apposition. The most important element in obtaining a good functional result is reeducation. All our patients have shown good power and tone in the muscles supplied by the two lower branches and none in those supplied by the upper branch, but all have had poor initial emotional control. They did not draw up the previously paralyzed corner of the mouth well on smiling but did so when told to close the eyes tightly. Concentration and practice before a mirror offer the solution. Royle's suggestion as to reeducation is good. Instead of having the patients make a great mental effort to move both sides of the face, he trains them to use the weak side by holding the normal side in a position of relaxation. He expressed the belief that few persons have complete control of one side only. Caution must be observed in cases of one type, that of contractures after neuritis due to contusion rather than to severance. Patients with this condition present contractures of the type in which the muscles of the previously paralyzed side supplied by the two lower branches are overactive and those supplied by the upper branch fail to function normally. Hot packs and diathermy to promote relaxation are of service in cases of this type, and the practice of facial motions must be stopped, as it aggravates the condition.

The failure of the upper branch to regain function was evident in all the patients in the present series and constitutes an interesting field for speculation. The most plausible explanation is that the muscle fibers are scant in the group of muscles supplied by this branch and probably degenerate before the regeneration of the nerve is complete. If so, this furnishes a good argument for the exponents of immediate secondary operation. Since we have not done immediate secondary operations, I cannot comment on this.

Sewall observed that the paralyzed eye closed in sleep and that in some cases of paralysis it could be almost completely closed. In one case, in which the complete severance of the nerve was demonstrated at secondary operation, the patient was able to close the eye voluntarily to a 2 mm. slit. I cannot explain this unless it is caused by a variable innervation by the third nerve. In four other cases this power of closure was not present until the voluntary power returned to the muscles supplied by the branches of the seventh nerve.

TECHNIC OF OPERATION

The technic developed employs the usual instruments for radical mastoidectomy and, in addition, previously unused sharp scalpels for severing the neuroma from the proximal end of the nerve and the fibrous tissue from the distal end. Exposure of the nerve in its vertical portion by means of gouges, the operator bringing to view the stylomastoid foramen first and then working cephalad, has been found to be the quickest method, as it orients the surgeon. It was especially serviceable in the last case, in which the canal, mastoid and middle ear were entirely filled with dense scar. The injury having been determined, the decompression is carried proximal to it far enough to permit removal of the neuroma or allow neurolysis and prevent the ensuing edema from choking off the proximal portion. In no case has the internal ear been opened.

The exact mode of using the gouges is to shave down on the nerve by strokes parallel to its long axis, until its course is represented by a line of visible nerve the thinness of a hair. A small trench is then cut back of the nerve, after which the overhang is fractured by means of a gouge directed across the nerve and held in the trench, inclined slightly toward the nerve. This fractured piece must not be pressed on the nerve. It is removed by engaging its lip over the nerve with a gouge and pressing it back into the prepared trench. In the region between the horizontal canal and the oval window, the nerve is uncovered in the manner already described, and the overhanging edges are fractured directly, there being no room to cut an offset trench.

The procedure used after this stage of the operation depends on the condition of the nerve. If it is constricted by scar tissue, neurolysis is effected by ballooning the sheath of the nerve with physiologic solution of sodium chloride; this procedure defines the constriction, which is incised in several places in a direction parallel to the long axis of the nerve. If the nerve is severed or hopelessly scarred, the neuroma on the proximal end and the fibrous tissue on the distal end are removed. It may be possible to approximate the ends directly by shortening the course of the nerve by lifting it forward from its bed and thus removing the knee and the lower bend observed at the stylomastoid foramen. If the gap is too large, a suitable graft from the saphenous nerve, which is readily exposed, may be used. Duel, who originated this procedure, now uses a homogenous graft, previously degenerated in its bed, from which it is removed when needed. Sutures procure approximation.

The after-care of the wound and graft is simple. All patients present the picture resulting from modified radical mastoidectomy; that is, the facial ridge is removed to the ossicles, which are left undisturbed, as is the drum. If the injury has occurred during radical mastoidectomy, the picture is that of complete radical mastoidectomy. How then does one proceed? In either case, no special dressing, such as gold-foil, is placed over the nerve, and no packing is used at any time. The mastoidectomy wound is closed after one has obtained as complete hemostasis as is possible. No treatment is required except to keep the canal clean and occasionally to insufflate it with boric acid powder with iodine. No attempt is made to investigate the site of the operation on the nerve, as such a procedure probably would result in spoiling the apposition. The tissue juices provide the best dressing and keep the nerve in better condition than anything else.

REPORT OF CASES

I wish to report a case of each type of repair mentioned, i. e., end-to-end anastomosis, neurolysis and nerve graft. Only pertinent facts in the histories will be given.

CASE 1: *End-to-End Anastomosis* (previously reported in 1931 [2]).—A woman, aged 23, had suffered complete paralysis of the left side of the face on recovery from the anesthesia for simple mastoidectomy twelve months before (fig. 1). At this time a modified radical mastoidectomy was performed, with exposure of the facial nerve from the region above the oval window to the neck. A gap, 2 mm. in length, was observed at the knee at the end of the track of what was probably a small curet. The neuroma of the proximal end was removed as well as the frayed distal margin. After the nerve was freed from its bed the ends could be sutured. Recovery began in seven months, when food no longer trickled from the mouth; in eight months the patient could close her eyes. The function of the

Fig. 1.—Photographs showing the preoperative appearance of the patient. *A* shows the face in repose; *B*, the patient showing the teeth, and *C*, closing the eyes.

Fig. 2.—Photographs showing the patient after recovery. *A* shows the face in repose; *B*, the patient showing the teeth, and *C*, closing the eyes.

corda tympani (which governs taste over the anterior two-thirds of the tongue) and of the branch supplying the frontalis muscle never returned, but the function of the other branches was normal in fourteen months, except that emotional control was not perfect, as may be seen from a study of the pictures (fig. 2). Emotional control is a matter of reeducation, but as the patient had two small children and did her own work, she did not cooperate much in this regard. The hearing was normal.

CASE 2: *Neurolysis.*—A woman, aged 23, had undergone a simple mastoidectomy forty-one days before consultation. She awoke from the first operation "unable to close her right eye or hold food in her mouth"; i. e., she had complete paral-

ysis of the right side of the face (fig. 3). The surgeon did not know that he had injured the nerve. We performed a modified radical mastoidectomy. The nerve had been exposed on its posterolateral surface in its upper vertical portion near the antrum for an area about 0.5 cm. in length. This area was covered by fibrous tissue, which by injection of a solution of sodium chloride was shown to constrict the nerve. Neurolysis was performed by Dr. Howard Brown. Forty-one days later muscular tone was much improved, giving almost complete symmetry of the

Fig. 3.—Photographs showing the preoperative appearance of the patient. *A* shows the face in repose; *B*, the patient showing the teeth and the absence of the nasolabial groove; *C*, the patient closing the eyes and the absence of the nasolabial groove, and *D*, the patient wrinkling the forehead.

face and emotional control; function of the frontalis muscle and the chorda tympani was lacking. Three months later there was good return of function in all but the frontalis muscle (fig. 4). The emotional control was poor, and the function of the chorda tympani was totally lacking, as it had been severed in lifting the nerve from its bed. A more detailed report of reeducation in emotional control, etc., cannot be given, as the patient promptly sued the first surgeon, and we did not wish to be involved further in the case. Hearing was normal.

CASE 3: *Nerve Graft.*—A boy, aged 9 years, had undergone a radical mastoidectomy on May 22, 1933, for the relief of dizziness, nausea and vomiting. He awoke from the operation with complete paralysis of the right side of the face. There

Fig. 4.—Photographs of the postoperative appearance of the patient. *A* shows the face in repose, with the frontalis muscle inactive; *B*, the patient showing the teeth and the return of the nasolabial groove, and *C*, the patient closing the eyes, with the nasolabial groove present.

Fig. 5.—Photographs of the postoperative appearance of the patient. *A* shows the face in repose; *B*, the patient closing the eyes and lifting the corner of the mouth well; *C*, lifting the corners of the mouth, and *D*, lifting the previously paralyzed side only.

were twitchings of the facial muscles for three months after operation, and then no further disturbance was noted, except that the right eye could not be closed and drooping of the right corner of the mouth was so marked that the patient ate with difficulty. Photographs before operation could not be obtained. We reopened the old wound, cleaned out a large cholesteatoma in Trautman's triangle and decompressed the nerve, except where it lay bare across the antrum as a fibrous cord about 0.5 cm. long. In other words, the nerve was normal for from about 3 to 5 mm. from the inner ear and was then replaced by the cord, below which the nerve trunk appeared normal. The resection of the cord left too wide a gap for an end-to-end anastomosis, even with complete mobilization. A saphenous nerve graft, therefore, was inserted and sutured into position. The posterior part of the wound was left open (the labyrinth was dead, and a small fistula in the horizontal canal was observed), but no complications followed. This wound healed rapidly. Because of the infected cholesteatoma, considerable drainage occurred for several months, and a large amount of soft granulation tissue sprang up near the graft. This shrunk to a polypoid mass after the sutures sloughed, and it was removed with a snare. The wound then healed. During this time the boy was given a harness, and the parents were shown how to use it. Unfortunately, no cooperation was received, as the boy did not like to wear the appliance. About nine months after the operation it seemed to us that the facial symmetry was better, but it was believed that this might be the result of contractures. After eleven months, however, the patient noticed that the corner of his mouth twitched and that he could pull it up a little. He could close his eyes almost completely, but there was no function in the frontalis muscle or the chorda tympani (fig. 5).

The pathologic examination of the excised nerve showed that the greater part of the material was composed of dense fibrous tissue. Several small nerve trunks and one of moderate size were partially or completely enclosed with the fibrous tissue. In other zones the nerve bundles were so small and had degenerated to such an extent that they were scarcely recognizable as nerve tissue.

The best result in emotional control is looked for in this patient because of his youth, for with young persons reeducation is easier.

COMMENT

A patient who has repair of the facial nerve must be reeducated in the emotional control of the facial muscles after muscular tone and movement have returned. Such reeducation is not easy. In our series two patients were too busy, and one was too much interested in the legal possibilities, to follow directions. In no case has the function of the frontalis muscle returned, but lack of this function is not so noticeable as one would expect. This is also true in regard to the chorda tympani.

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ABSTRACT OF DISCUSSION

DR. STERLING BUNNELL, San Francisco: Dr. Martin has given a straightforward report. His results are reliable and are a real contribution to intratemporal repair of the facial nerve. I have personally seen the patient in his first case and can vouch for the degree of regeneration he claims.

Intratemporal repair of the facial nerve is now on a firm foundation. The method of repair by anastomosis is obsolete, as it does not restore emotional expression and dissociated movements occur. The indication at present is either to repair the facial nerve or to perform a muscle plastic operation.

My experience with intratemporal repair comprises four cases. The first case was in 1925, and the operation constituted the first successful intratemporal suture of this nerve. The second case was in 1928. The facial nerve was repaired at the geniculate ganglion and a gap of 23 mm. between the ends of the nerve was readily overcome by the method of rerouting.

The third case was one of tumor of the facial nerve; so a segment of the nerve from the middle ear to the parotid gland was removed. The gap in the nerve was bridged by a three branch free graft, measuring 2½ inches (6.4 cm.), taken from the sural nerve of the leg. In eight months symmetry of the face was established, and in seventeen months voluntary motions were present in all the muscles of the face, except the frontalis and the platysma muscle. This was the first instance of successful intratemporal repair of the facial nerve by nerve graft. It was performed in 1930. The first nerve graft, by Balance and Duel, was made in 1931 and was reported in the following year. In my case the tumor proved to be malignant; so two years later I removed the whole block of tissue and obtained microscopic sections which showed growing nerve fibers throughout the length of the graft.

In my fourth case the repair was made in 1935. A gap of 15 mm. just below the bend was readily overcome by rerouting. Voluntary motion was first noticed five and one-half months later. At present, six months after operation, the face is symmetrical when at rest, and voluntary movements are present in the forehead, eyelids and mouth.

In intratemporal repair of the facial nerve the principles learned from suture of nerves in general apply. The only unusual aspects in repair of the facial nerve are that the location makes the repair mechanically difficult and the regeneration of this nerve is especially good, because it lies well to the periphery, where repair is best, and is practically a pure nerve, there being only a minority of axons for its functions other than motor. The degree of regeneration is directly in proportion to the accuracy of the union. Therefore, as in all other cases of nerve repair, the ends of the nerve should not merely be laid together without suture; the operation should not be done in the presence of pus or even of granulation tissue, and dead spaces should not be left, or the result will be mediocre. In cases of such poor repair there is much fibrous tissue between the ends of the nerve, and fewer axons bridge across than should.

I am convinced of the validity of these statements after experience in over one thousand cases of nerve repair. Many of these were instances of repair of tiny nerves in the hands and fingers, and these cases have taught me that no nerve which can be sutured is too tiny to regenerate. This applies also when branches of the facial nerve are sutured distal to the parotid gland. Also, in my series of twenty-five cases of nerve graft good regeneration was recorded in all but one instance, in which the patient could not be traced. I believe that the reason for this success is that the grafts were made in very small nerves, so that the full thickness of the graft was nourished in the surrounding lymph, the inevitable central necrosis which occurs in larger nerve grafts being thus avoided.

Though nerve grafts of the facial nerve are successful, I believe that in most instances in which the nerve has been injured in a mastoidectomy the gap in the nerve can be closed by rerouting and that when its use is possible this method is preferable. The length of the nerve from the bend to the stylomastoid foramen is 20 mm., and the length from this point to the parotid gland, 30 mm. A direct line from the bend to the parotid gland measures 40 mm., as the angle of the nerve at the stylomastoid foramen is 105 degrees. Thus at the bend 10 mm.

is gained by rerouting. Two more millimeters is gained by teasing the branches of the nerve from the parotid gland, and 4 mm., by suturing the parotid gland to the region of the mastoid process. Thus, when the nerve is severed at the bend, 15 mm. can be gained by rerouting. When the nerve is severed at the geniculate ganglion, if one assumes that the horizontal part of the facial nerve is 12 mm. in length and that a direct line from the parotid to the geniculate ganglion measures 44 mm., 18 mm. is thus gained, and with the additional 2 and 4 mm. it is possible by rerouting to overcome a gap in the nerve of 23 mm.

The use of "prepared" nerve grafts has been advised. The reports of Huber and Cajal in this respect are only moderately encouraging; so I believe that the burden of proof still rests on the exponents of this method. Also, in consideration of the fact that by chiseling away the vaginal process rerouting of the facial nerve makes nerve grafting necessary in only a small proportion of cases, it seems hardly advisable to "prepare" a nerve graft in every case.

VARIATION OF THE PEDICLE FLAP FOR EPITHELIATION OF THE RADICAL MASTOIDECTOMY CAVITY

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AND
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PHILADELPHIA

Our purpose in this communication is to report a new type of pedicle flap operation to be used in the epitheliation of the radical mastoidectomy cavity. This graft, in our opinion, is especially valuable in cases in which previous mastoidectomy has been performed and there is lack of epidermis. This variation in the technic, as far as we can ascertain by a careful search of the literature, has not previously been reported.

The aim in the treatment of chronic suppurative otitis media, with or without cholesteatoma, is the production of a dry ear. If all attempts at conservative treatment fail, radical mastoidectomy is often employed. At times the radical surgical treatment must be carried out as an emergency procedure to forestall the development of intracranial complications or because of symptoms of labyrinthine involvement.

One of the disadvantages of the radical operation is that even after its performance the surgeon is unable to assure his patient that a dry ear will be obtained. Many factors are responsible for this, which it is not within the province of this paper to discuss.

It has been shown that healing in cases of chronic suppurative otitis media is in direct relation to the extent of epidermization by squamous epithelium, which is ectodermal in origin. This mechanism in the middle ear differs from the process of healing in other parts of the body. Elsewhere healing takes place by means of mesodermal tissue, which eventually becomes mature fibrous connective tissue. Squamous epithelium is nature's means of healing the middle ear. The cholesteatoma matrix is formed of squamous epithelial cells and is an attempt at healing. The foremost exponents of this theory have been Nager,[1] Wittmaack,[2] Kopetzky,[3] Almour[4] and others. Kopetzky and Almour, in

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Presented before the Philadelphia Laryngological Society on Oct. 2, 1934.

From the Department of Otology, the Temple University School of Medicine.

1. Nager, F. R.: Personal communication to the authors.

2. Wittmaack, K., in Henke, F., and Lubarsch, O.: Handbuch der speziellen pathologischen Anatomie und Histologie, Berlin, Julius Springer, 1926, vol. 12, p. 246.

3. Kopetzky, S. J.: Cholesteatoma, Laryngoscope **43**:118 (Feb.) 1933.

4. Almour, R.: The Significance of Squamous Epithelium in Cause and Repair of Chronic Middle Ear Disease, Tr. Am. Acad. Ophth. **35**:357, 1930.

agreement with the teachings of Nager, have suggested that the cholesteatoma matrix be left in place as an epithelial lining membrane if it is encountered during the performance of the radical mastoidectomy.

The need for the presence of epithelial tissue in the middle ear has long been felt. It is therefore not strange that otologists for many years have attempted to introduce epithelial tissue into the middle ear and mastoidectomy cavity, in order to hasten healing and procure a dry ear. The earliest endeavors involved plastic procedures on the external auditory canal, in order to obtain islands of epithelial tissue that would eventually line the entire mastoidectomy cavity and the middle ear. The amount of epithelial tissue resulting from the various plastic flaps placed on the external auditory canal has often proved inadequate; so in many cases various other methods have been attempted. The earliest efforts were directed to the introduction of Thiersch skin grafts. Robison [5] has reviewed the early history of grafting admirably, and we cite freely from his article. The technic of grafting was first reported, in 1893, by Siebenmann, who used secondary skin grafting; Reinhard, in 1893, used primary skin grafting. Denker (1897), Panse (1899), Ballance (1900), Scott (1912, Marriage (1915) and Beck (1915) were pioneers who recommended and used skin grafts.

During all these years there has been a difference of opinion as to the desirability of primary as compared with that of secondary skin grafting. Some authors have held that grafts will not adhere to newly cut surfaces of bone and have stated that granulation tissue is necessary in order to obtain growth of these grafts. This method necessitates a second operation in order to place the Thiersch graft.

Recently, Daggett and Bateman [6] described a technic for placing numerous small Thiersch grafts through the external auditory meatus and reported favorable results from the use of this method.

Other authors, in order to secure better growth of the epithelium and closure of the eustachian tube, have used grafts of temporal muscle, as described by Kisch.[7]

Smyth [8] described the use of a periosteal flap in conjunction with a plastic procedure on the external auditory canal. Ziegelman [9] devised

5. Robison, J. T.: The Radical Mastoid Skin-Graft, Texas State J. Med. **29**:525 (Dec.) 1933.

6. Daggett, W. I., and Bateman, G. H.: Secondary Thiersch Grafting of the Radical Mastoid Cavity Through the Meatus, J. Laryng. & Otol. **49**:169 (March) 1934.

7. Kisch, H.: The Use of Temporal Muscle Grafts in Mastoid Operations, J. Laryng. & Otol. **43**:856 (Dec.) 1928.

8. Smyth, D. C.: Skin-Periosteal Flap for Radical Mastoid, Ann. Otol., Rhin. & Laryng. **35**:442, 1926.

9. Ziegelman, E. F.: Use of Periosteal Flap with Skin Graft in Radical Mastoid Surgery, Laryngoscope **42**:170 (March) 1932.

a modification of the Smyth technic, in which a Thiersch graft is sutured to the periosteal graft.

Despite the various technics devised for the use of Thiersch grafts, unfavorable results have occurred in many cases; so still other methods were sought. The pedicle graft appeals to us as a method worthy of trial, because the epithelial tissue receives nourishment while it is growing and the method obviates the necessity of a secondary operation in order to place the graft. Kahn [10] described a pedicle graft taken from the posterior lip of the mastoidectomy incision. The graft is held in place by packing, and the wound is closed over it. A somewhat similar procedure, in which also the pedicle flap obtained from the posterior lip of the mastoidectomy wound is used, was described by Ross and Joyce.[11]

The aforementioned technics are valuable, but they have certain limitations. The following disadvantages may be enumerated: If there have been previous operations on the mastoid, the postauricular scar or scars do not permit removal of skin from the posterior lip of the mastoidectomy incision, as it is practically impossible to close the wound. If the closure is too difficult or the gap is too wide to bridge, a persistent postauricular fistula may result, which defeats the purpose of the radical operation. Also, the amount of skin that may be obtained is limited, which is not so in the operation we describe.

In our procedure the pedicle graft is taken from the lower angle of the mastoidectomy incision, which is extended into the skin of the neck. Then the flap is turned into the mastoidectomy cavity, and the mastoidectomy incision and the wound in the neck are closed. In conjunction with this flap, the Panse flap on the external auditory canal is also used. Thus, two sources of epithelial growth are obtained, with a correspondingly greater chance for epitheliation of the cavity and a resultant dry ear.

We have used this procedure in two cases; in each instance a dry ear has resulted in from five to eight weeks. A description of the operative technic follows:

1. The usual curvilinear and postauricular mastoidectomy incision is made.

2. The radical mastoidectomy is performed.

3. The Panse plastic flap procedure is done on the external auditory canal.

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10. Kahn, A.: A New Method for Skingrafting the Mastoid Cavity: A New Method for Closing Off the Eustachian Tube at Its Tympanic End in the Radical Mastoid Operation, Laryngoscope **37**:889 (Dec.) 1927.

11. Ross, E. L., and Joyce, W. M.: New Modification of Radical Operation on Mastoid: Preliminary Report, Arch. Otolaryng. **7**:583 (June) 1928.

4. The lower angle of the mastoidectomy incision is continued into the neck, and a pedicle graft is raised in the shape of a racket (fig. 1*A*). This incision is best marked out first with the point of the scalpel, the size of the graft depending on the size of the mastoidectomy cavity and the middle ear. The incision is then continued to the superficial

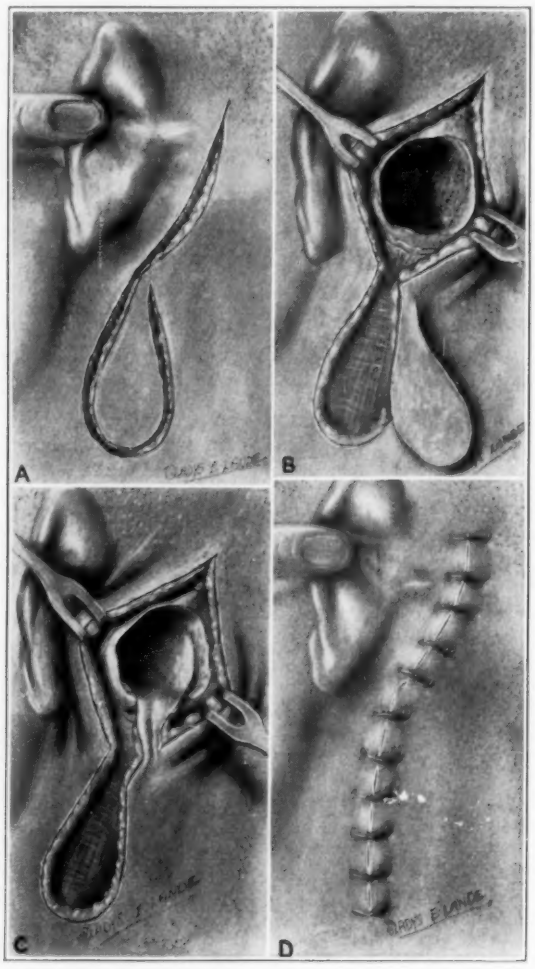

Fig. 1.—Drawings showing: (*A*) continuation of the mastoidectomy incision into the neck and the shape of the pedicle graft prior to dissection; (*B*) the pedicle flap after dissection and prior to being placed in the mastoidectomy cavity; (*C*) the pedicle graft turned on its neck and placed in the mastoidectomy cavity, and (*D*) the linear line of sutures closing the mastoidectomy wound and the area from which the pedicle flap was taken.

fascia. By sharp dissection with the scalpel the pedicle flap is raised as far as the neck of the graft and is cut through on its anterior aspect, mobilization being thus secured (fig. 1*B*).

The pedicle flap is then turned on its neck and placed in the mastoidectomy cavity (fig. 1*C*), and it is smoothed out and held in place by a packing of plain gauze, which is led through the external auditory meatus. The pedicle graft is turned down by the ordinary method, similar to the procedure employed in turning down a flap of skin from the forehead in order to build a new nose.

The neck of the pedicle flap is then scarified in a straight line with the posterior edge of the mastoidectomy incision. The anterior and posterior lips of the mastoidectomy wound are closed over the pedicle, and the anterior edge of the incision is sewed over the neck of the

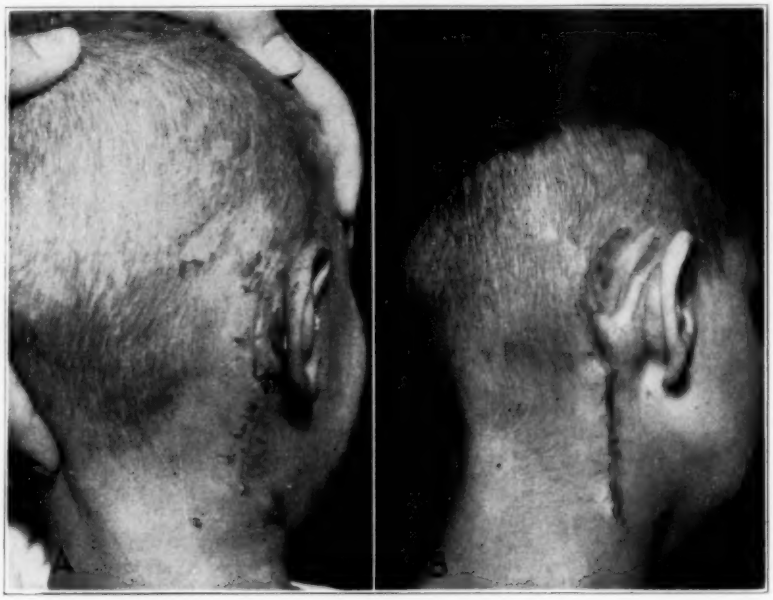

Fig. 2.—Appearance of the scar (*A*) in the first case in which the pedicle flap operation was performed and (*B*) in the second case in which the pedicle graft was utilized after radical mastoidectomy.

pedicle, where it has been scarified. The closure of the area from which the graft has been taken is then easily accomplished by dissecting the tissue on each side of the incision, so as to mobilize the skin.

With this method a linear scar is obtained from the mastoidectomy incision into the neck (fig. 1*D*). The sutures are removed on the fifth day. The packing in the external auditory canal is left in place undisturbed for from three to five days and is then gradually removed, so that by the seventh or eighth day all the packing is removed. The wound is then watched carefully; excess secretions are wiped away

daily, and after about ten days a dusting powder, such as thymol iodide, boric acid with iodine, or zinc stearate, may be used.

The technic of this operation is relatively simple and gives a readily available source of epithelial tissue. We have employed the procedure in two cases. In the first case (fig. 2*A*) the patient had had three previous radical mastoidectomies and was referred to us for relief of the cholesteatomatous condition, which had recurred. On completion of the mastoidectomy, we found that neither was the skin of the posterior aspect of the mastoidectomy incision available for grafting by the method of Kahn or Ross and Joyce nor was enough of the external auditory canal present for the use of a Panse flap. The pedicle flap method was used, and in four weeks a dry ear and a healed mastoidectomy cavity were obtained. Until the present, one year after operation, no discharge has recurred.

In the second case (fig. 2*B*) a boy, aged 3 years, had had a simple mastoidectomy one year before, after scarlet fever. The discharge persisted, and an acute exacerbation resulted, necessitating secondary mastoidectomy. On operation the mastoidectomy cavity and the middle ear were observed to be eroded by a cholesteatomatous mass, and a radical mastoidectomy was performed.

The pedicle graft was utilized as described, and healing followed rapidly with a resultant dry ear.

Clinical Notes

QUANTITATIVE STUDY OF NASAL OBSTRUCTION

A New Method

H. J. Sternstein, M.D.,* Boston, and M. O. Schur, B.S.,† Berlin, N. H.

The dynamics of nasal respiration both in its normal and in its pathologic state has been variously studied. As yet a satisfactory basis has not been established for the determination of the resistance, accommodation and shrinkage capacity of the nasal air way. The rhinologist has always been confronted with these phenomena but has had no adequate method for their quantitative evaluation. The present investigation was, therefore, undertaken in an endeavor to standardize these factors and thereby furnish an index of the respiratory efficiency of the nasal tract. For this study a special manometer was devised.

Various nasal manometers have been described by Undritz,[1] O'Malley,[2] Krimsky [3] and others [4] in clinical and physiologic studies related to nasal respiration, but the procedures involved were either time-consuming or difficult for the patient. With the simplified apparatus herein presented a quantitative measurement of nasal obstruction is obtained independent of the nasal respiratory activity.

The instrument, which embodies a draft gage and an air flowmeter, establishes the resistance of the nasal air way by measuring the pressure required to draw a given volume of air at a known velocity through the postnasal and nasal passages with the subject breathing entirely through the mouth. The more marked the nasal impairment, the greater is the resistance to the air flow and consequently the higher the draft gage reading. Figure 1 illustrates the salient features of the apparatus.

DESCRIPTION OF APPARATUS

The apparatus, as shown in figure 1, consists of a nosepiece (*F*) with two branches, one of which leads to the draft gage (*E*) and the other to an air flowmeter. The gage (*E*) is inclined ¼ inch per inch (0.7 cm. per two and six-tenths centimeters) length of the scale to provide sensitivity; the flowmeter has a differential manometer (*D*), which measures the drop in pressure across the air friction tube (*C*). An aspirator (*A*) or some other suitable source of suction, such as a vacuum pump, is attached through a regulating clamp (*B*) to one side of the flowmeter, and a safety-bottle is interposed between the other side of the flowmeter and the nosepiece (*F*) to prevent excessive suction at the nose.

* Member of the Nose and Throat Department of the Beth Israel Hospital.

† Technical Director of the Research Department, Brown Company.

1. Undritz, W.: The Rhinoanemometer, Acta oto-laryng. **14**:513, 1930.

2. O'Malley, J. F.: Ventilation of the Nose and Accessory Sinuses, J. Laryng. & Otol. **48**:309 (May) 1933.

3. Krimsky, E.: Dynamics of Nasal Respiration, Arch. Otolaryng. **16**:705 (Nov.) 1932.

4. Zwaardemaker, H.: Physiologie der Nase und ihrer Nebenhöhlen, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohren-Heilkunde, Berlin, Julius Springer, 1925, vol. 1, p. 439, footnote 1.

The flowmeter is calibrated at 20 C. and at a barometric pressure of approximately 760 mm.

PROCEDURE

A clinical history is taken with special reference to the frequency, duration and type of nasal blockage. Clinical findings before and after shrinkage are recorded in the examination of the nose, throat and postnasal space.

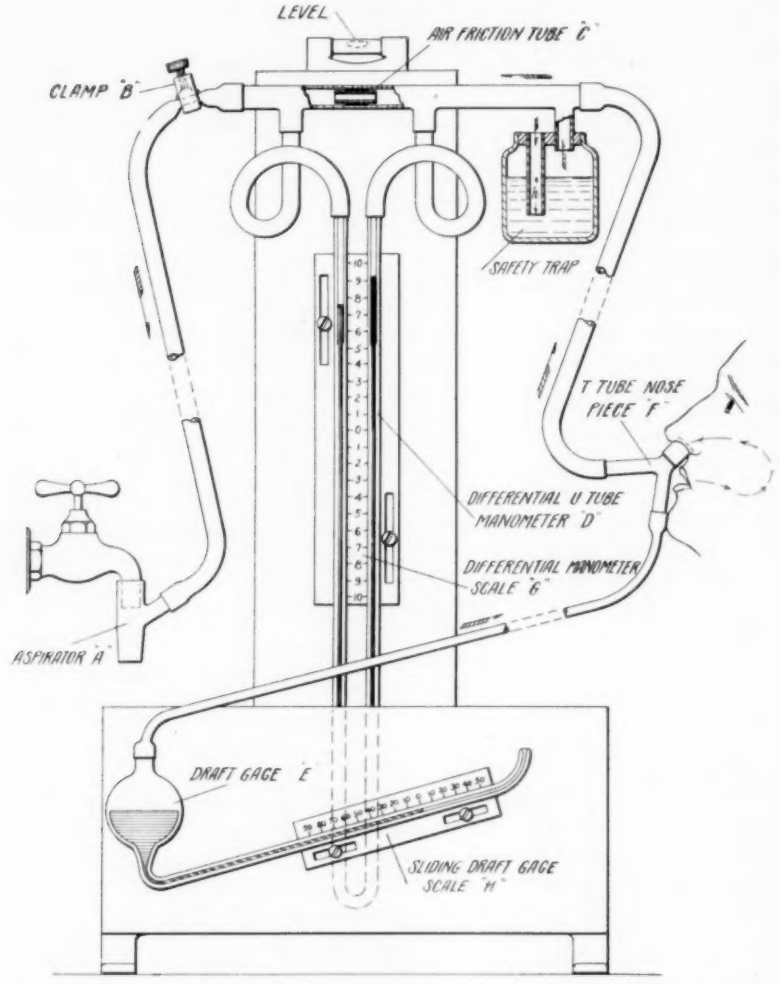

Fig. 1.—The apparatus employed to gage the respiratory resistance of the nasal air way. Note the direction of the air flow as indicated by the arrows.

The apparatus is leveled. The sliding draft gage scale is set at zero and the depth of the safety-trap (*h*) is fixed to limit the maximum suction at the nosepiece (*F*) to 2 or 3 inches (from 5 to 8 cm.) of water. Suction is adjusted with a clamp (*B*) until the differential manometer scale indicates a flow of 0.5 cubic foot, or 14.4 liters, of air per minute through the friction tube (*C*) and is then shut off.

To begin the test, the nozzle (*F*) is inserted tightly into the subject's left nostril while the right nostril remains open. The patient is instructed to breathe entirely through the mouth and cautioned against swallowing. If this should prove difficult, the patient's tongue is held forward by the examiner to avoid erroneous readings. The suction is then applied consecutively in several steps up to 14.4 liters per minute while corresponding sets of readings on the draft gage are recorded. The duration of the flow of air throughout the test is arbitrarily fixed at one minute. A glass of water is available for the subject between readings to relieve the frequent dryness of the pharynx produced by oral respiration. The series of tests is next repeated with the right nostril closed. The nozzle is then transferred to the right nostril, and two new series of measurements are taken.

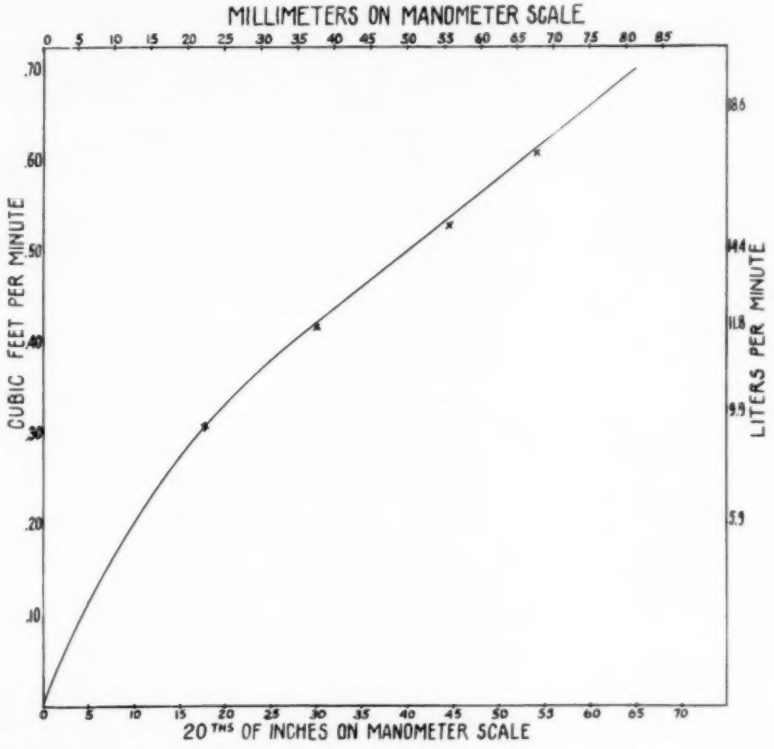

Fig. 2.—A typical calibration curve showing the volume of air (cubic feet or liters per minute) passing through the flowmeter at normal room temperature (20 C.) and at a barometric pressure of 760 mm.

Five-tenths per cent cocaine hydrochloride is then sprayed into the nose, and after an interval of twenty minutes, to allow for complete vasoconstriction, the entire series of measurements is repeated.

The air flow can be regulated by the flowmeter to correspond with the rate of flow per minute of physiologic nasal respiration under varying conditions.

Oral respiration as employed throughout the procedure eliminates respiratory activity in the nasopharynx and nasal fossae to permit accurate resistance measurements of the nasal air way.

BASIC THEORY

The nasal chambers and the postnasal space represent a two tube system. In figure 3*a* *L* and *R* represent the nasal cavities separately, and *M* represents the postnasal space and oral cavity. The degree of suction applied directly to the opening of *L* or *R* depends on the number of liters of air withdrawn per minute and on the friction created in *M*, *L* and *R*. If a constant rate of air flow through *R* is maintained, the suction at *R* becomes an index of the friction. Although the friction in *L* is of the same order of magnitude as the friction in *R*, variations in

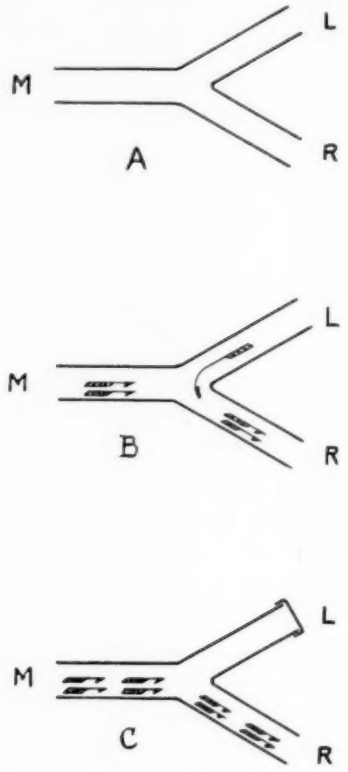

Fig. 3.—*A*, schematic diagram of the nasal air ways and the postnasal space. *L* represents the left nostril; *R*, the right nostril, and *M*, the mouth and postnasal space. *B*, air flow with the opposite nostril (*L*) open and suction applied at *R*. Note that all the air flowing through *L* and *M* travels through *R*. *C*, air flow with the opposite nostril (*L*) closed and suction applied at *R*. The friction index at *R* is materially influenced by variations in *M*.

L do not affect the suction at *R* to the same extent as would a similar variation in *R*, for most of the air coming through *R* flows through *M* (fig. 3*b*).

To determine the effect of variations in *M* the open end of *L*, i. e., the nostril, should be closed off during the test. The suction at *R* may then be slightly higher, since all the air must now enter through *M* (fig. 3*c*).

COMMENT

The apparatus was originally designed to furnish an objective basis for the determination of air resistance phenomena in the nasal air way introductory to a study of intranasal filters for removing allergic pollens in cases of hay fever, but from the preliminary data thus far obtained and the adduceable evidence it is apparent that its scope of application may be more widely extended to include allied physiologic and clinical studies, such as the accommodative reaction of the nasal passageway to variations in temperature, barometric pressure, humidity and vital capacity; the shrinkage efficiency of nasal medication commonly employed for vasoconstriction in the nose; the effect of local anesthetics on the accommodative reflex of the nasal air way; the physical and physiologic factors involved in the erectile phenomena of turbinal tissues; the effect of improved nasal ventilation on the clinical course of nasal or bronchial asthma; the clinical value of a graphic record in the treatment of nasal obstruction; a simple diagnostic method for the detection of postnasal abnormalities; the clinical aspect of nasal ventilation as related to disease of the upper and the lower respiratory tract, and the dynamics of nasal ventilation as related to the problem of sinus drainage.

SUMMARY

A simplified apparatus and procedure are presented for the quantitative measurement of nasal obstruction, which is obtained independent of nasal respiratory activity. In contradistinction to other known methods, a draft gage is combined with an air flowmeter for measuring the resistance of air drawn at different velocities through the nasal air way. It is believed that this method of investigation offers a rational basis for the diagnosis and treatment of impaired nasal respiration.

A report of further study will follow.

371 Commonwealth Avenue.

PIPE-STEM IMPACTED IN THE TONSIL FOR FIFTEEN MONTHS

Report of a Case

KAGEYAS W. AMANO, M.D., TOKYO, JAPAN

A case of a foreign body in the tonsil or pharynx occurs frequently but is seldom serious. Ordinarily such a foreign body is coughed up spontaneously or expelled because of nausea. Thus, few patients consult specialists, most of them coming for the removal of fish-bones, spicules of other bones, bristles of a tooth-brush, etc., which are sticking in the crypts of the tonsil. A foreign body is never lodged in the same location for any length of time, because patients ordinarily seek medical treatment promptly.

In the outpatient department of the White Memorial Hospital a man consulted me for the treatment of sore throat. An impacted foreign body was found embedded in the tonsil. It consisted of about 4 inches (10.16 cm.) of the black, ebony-like, hard rubber mouthpiece of a smoking pipe with the upper end buried in the tissue of the tonsil and the other end floating somewhere in the hypopharynx. In spite

From the Department of Otolaryngology of the College of Medical Evangelists, Los Angeles.

of the object having been embedded there for the past fifteen months, the patient had had no sensation of a foreign body, and the condition had also been overlooked by laryngologists.

Dr. Chevalier Jackson,[1] in a personal communication, stated that this pipe-stem was probably the largest foreign body ever removed from the tonsil, and he pointed out its interest from the standpoint of prophylaxis in similar cases which might arise in the future, such as in an accident befalling a child while sucking a lollypop.

Fig. 1.—Roentgenogram taken after tonsillectomy.

C. L. Jackson[2] had a recent case of this kind in which extensive and fatal trauma was present, though the stick had been expelled before the child was brought in.

REPORT OF CASE

J. H., a married man aged 60, came to the White Memorial Clinic on Oct. 30, 1933, complaining of a dull pain in the right side of the throat during the past month. On May 19, 1932, the patient stumbled from a street-car, bruising

1. Jackson, Chevalier: Personal communication on July 23, 1934.

2. Jackson, C. L., cited in the personal communication of Dr. Chevalier Jackson.[1]

his nose and cheek. He did not lose consciousness and was able to return home. Owing to a sore neck the patient was absent one day from work. Since the pain persisted in the right side of the throat, he consulted his private physician, who referred him to the White Memorial Clinic. There he was examined by staff physicians, and a diagnosis of subacute tonsillitis was made. The symptoms soon subsided, but his wife stated that in May 1933 the patient suddenly coughed up a piece of a hard material about one-half inch (1.27 cm.) long, which she had carelessly thrown away. On August 4 of the same year, after soreness of the throat for two months an abscess in the throat (peritonsillar abscess?) had been lanced and curetted. The patient felt somewhat relieved, but chronic irritation with drainage of mucus from the throat persisted. During the month prior to his admission, soreness in the same region had recurred.

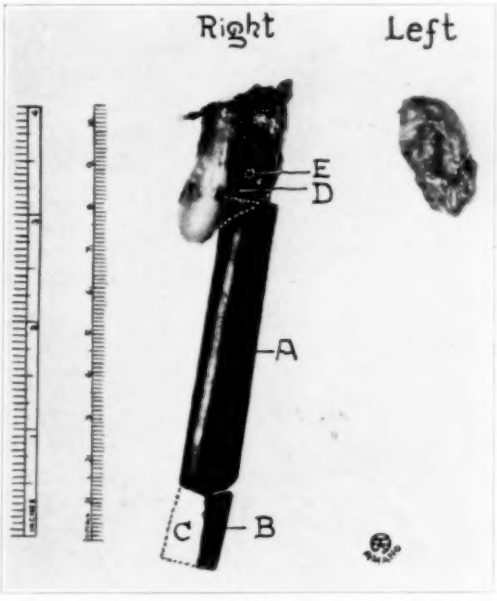

Fig. 2.—Photograph (Dr. Pratt) of the pipe-stem and tonsils after removal. *A* shows the main pipe-stem; *B*, the tip held in the mouth which was coughed up during tonsillectomy; *C*, the missing part, which had previously been coughed up; *D*, the portion embedded in the tonsils, and *E*, the spot observed before extraction.

Past History.—The patient had always enjoyed robust health and had been free from mental illness. He was not addicted to the use of alcohol.

Physical Examination.—The patient appeared well developed and of normal mentality and showed no apparent evidence of chronic infection. Locally, there was an apparently slight swelling of the lower jaw on the right side without inflammatory change. Palpation elicited slight tenderness on pressure. The right tonsil appeared more enlarged than the left and gave evidence of chronic hypertrophy without acute inflammation. It was markedly enlarged toward the lower pole; its lower portion was therefore not visible. The left tonsil was small and rather embedded between the pillars. On depression of the tongue a small black speck appeared in a crypt in the middle of the lower part of the right tonsil. Indirect laryngoscopic examination with a mirror revealed nothing of significance.

Operative Procedure.—By applying a probe over the black spot, the resistance of the hard material was felt. An immediate diagnosis of foreign body was made. With a biting forceps, the object was grasped tightly, and with an upward pull the stem of a smoking pipe about 4 inches (10.16 cm.) in length was easily extracted. The patient suffered no bleeding or pain during the manipulation. This incident greatly astonished all the physicians of the hospital as well as the patient, who could not recall ever having swallowed the pipe-stem, even at the time of the accident on the street-car. After the extraction tonsillectomy was performed with the patient under local anesthesia. During the injection of the anesthetic the patient coughed up a small chip of the pipe-stem. In spite of adhe-

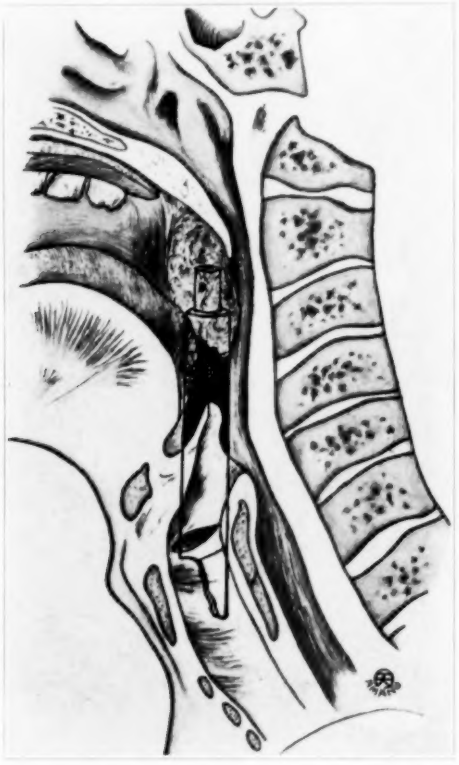

Fig. 3.—Schematic drawing of the impaction.

sions, there was little bleeding during the operation, and the patient made an uneventful recovery. The right tonsil measured 3.8 by 2.5 cm. The lower half appeared smooth and chronically hypertrophied. A deep fissure running longitudinally in the middle of the lower part of the tonsil had formerly been filled by the pipe-stem. The upper part was cryptic and contained cheesy material. The left tonsil, which was embedded, measured 2.5 by 2 cm. and was not unusual in appearance. A roentgenogram taken after tonsillectomy showed no trace of a remaining foreign body (fig. 1).

Appearance of the Foreign Body.—The pipe-stem was of ordinary hard rubber, 10.7 cm. in length and 1.2 cm. in diameter at one end and 0.8 cm. in diameter at the

other. The end held in the mouth was partially chipped off. The lower part of the stem, which had been embedded in the tonsillar tissue, appeared dull and smooth; the middle portion was somewhat roughened with fibrous, flaky material, while the upper part appeared glistening and smooth. The broken chip coughed up during the operation was a triangular piece measuring 0.4 by 0.5 by 1.7 cm. and fitted exactly with the main stem, completing the end held in the mouth with the exception of the missing part which had been coughed up in May 1933 (fig. 2).

COMMENT

On close examination of the extracted pipe-stem, the third, or the lower portion, of the stem which had been embedded in the tonsil was found to be smooth and clean, while the middle third appeared to be covered with a grayish-white coating. This raised the question whether this part might have been in contact with the wall of the hypopharynx or whether it might have floated free in that space in direct contact with the swallowed food. The last third or the tip of the pipe held in the mouth, showed no evidence of soiling, proving that it must either have been free in the hypopharynx or have been lodged in the sinus pyriformis.

The chipped fragment of the mouthpiece which was coughed up by the patient during tonsillectomy, must have been lodged somewhere in the neighborhood of the epiglottis and have fitted closely to the missing part of the broken pipe-stem which was expelled five months previously by the patient.

In taking this case into consideration, it is necessary to bear in mind both the patient's postoperative roentgenogram and the pieces of extracted pipe-stem in order to visualize how such a long pipe-stem could have been lodged in as narrow a space as the hypopharynx during so long a time without causing more symptoms. Perhaps at the time of the accident, the foreign body may have been inserted deeply with sudden pressure and a space have been formed in the soft tissue causing it to be embedded there, or owing to pressure the tip of the stem held in the mouth (the lower end in position) may have remained in the hypopharyngeal space, and the part of the stem nearest the bowl (the upper end in position) have become impacted in the tonsil which surrounded it with granulation tissue (fig. 3).

This case is reported as one in which a foreign body was removed from the tonsil in which it was discovered, but in reality it may be considered as one in which an object was extracted from the tonsil and pharynx.

CONCLUSION

One seldom finds a case, such as that reported here, in which a pipe-stem has been impacted in the tonsil for such a length of time without causing more disturbance or discomfort to the patient.

The delay in the discovery of the foreign body may be attributed to the lack of roentgenography at the time of the accident and later when the patient consulted physicians for examination of the throat.

In the practice of otolaryngology any trauma about the neck or the swallowing of a foreign body should be an indication for roentgenography, in order to prevent delay in the diagnosis of the trouble and in the treatment of the patient.

An accident due to a foreign body, such as that which occurred in this case, should be a warning to all those who are in the habit of carrying a pipe in the mouth or to children sucking sticks of candy or lollypops, so that, as Jackson has suggested, further accidents of a similar nature may be prevented.

No. 1 Kutsukakecho, Suginamiku, Tokyo, Japan.

MORPHOLOGIC CHARACTERISTICS OF THE SINUSES

JOHN J. SHEA, M.D., MEMPHIS, TENN.

Nature has designed a program of development for the pneumatized spaces of the mastoids and the paranasal sinuses. Experiences suffered by these parts during the period of their formation are reflected in their growth and development. The history of the patient may reveal previous infections, but a study of the morphologic features of the sinuses will disclose their influence. The application of this knowledge is valuable in determining whether a present infection is entirely acute or whether it is an exacerbation of a chronic condition.

HEREDITY

Heredity is the greatest factor in determining the size and shape to which the sinuses are destined to develop. The sinuses of a child will assume the shape of those of the ancestor whom he resembles in facial appearance, provided neither has suffered an arrest of development of the sinuses.

FRONTAL SINUS

The frontal sinus readily lends itself to the study of its development because of the ease with which the size and shape are demonstrated in a roentgenogram. As early as the end of the second year an anterior ethmoid cell migrates upward into the frontal bone to form the frontal sinus. If this migration is delayed past the fourth year the frontal sinus will not mature to its natural size unless pneumatization is stimulated. At puberty the frontal sinus has lost the shape of a culdesac and becomes notched by the appearance of the partial septums. The diameters at this time are about equal. The extent of pneumatization is determined by the inherited tendency. The possibility of duplication of the frontal sinus must be constantly remembered when one is establishing drainage, as each sinus communicates separately with the nasal cavity. Diverticula of the frontal sinus are rare, but they are capable of extending into embarrassing positions. Pneumatization of a supra-orbital ethmoid cell outward and under the frontal sinus results in a cavity which is photographed on the roentgenogram as darker than either the frontal sinus or the orbit. This space often produces a vacuum headache when its opening is blocked. The encroachment of this supra-orbital ethmoid cell elevates the floor of the frontal sinus to form the frontal bulla, narrowing the frontal duct. The clinical significance is important in the determination of a probable cause of headache, and a thorough exposure is necessary when a radical operation is performed, lest the cavity of this cell be mistaken for the frontal sinus.

In these days of frequent accidents in transportation, the frontal sinus receives its share of injuries. Should the fracture involve only the anterior or the inferior wall, the frontal duct may be relied on for drainage; but when it involves the posterior wall, a thorough exposure is required and, if necessary, an inspection of the dura. During healing care must be taken to control the unlawful growth of mucous membrane through the line of fracture, for such a condition has possibilities of intracranial complications.

Address of the Chairman of the Section on Laryngology, Otology and Rhinology at the Eighty-Sixth Annual Session of the American Medical Association, Atlantic City, N. J., June 13, 1935.

MAXILLARY SINUS

The maxillary sinus is the most constant of all the sinuses. Starting as a "slitlike cavity" in the membranous lateral wall of the nose, it continues to grow throughout life by a process of pneumatization and encapsulation. If the teeth are retained its size is increased in the aged person by thinning of the bony walls and atrophy of the lining membrane. Babson, in a personal communication, stated that the total loss of the upper teeth results in diminishing the size of the maxillary sinus by allowing the outer angle to recede upward.

At birth the cavity is smaller than the bud of a deciduous first molar. During the first year it occupies an anterior position beneath the orbit, which accounts for the ease with which the sinus of the infant may rupture into the orbit. There is a close relationship between the deciduous teeth and the maxillary sinus. At the age of 5 months the deciduous teeth are in position beneath the floor of the sinus, while the invisible buds of the permanent molars are stacked behind the posterior wall. As the first dentition progresses, the cavity of the sinus rapidly

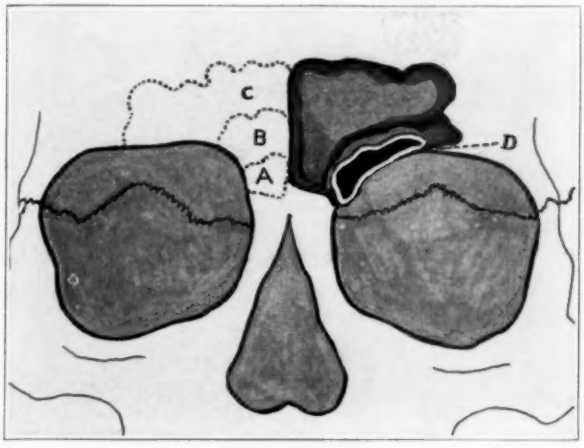

Fig. 1.—Drawing showing the relative heights of the frontal sinus at different periods of development. In *A* is indicated the position at the age of 3 years; in *B*, that at puberty, and in C, that in the adult. An uncapped supra-orbital ethmoid cell is shown in *D*.

increases, and at this time the internal wall is in closer relation to the middle nasal meatus than to the inferior. The clinical significance of this relation is that the middle meatus affords an easier approach than the inferior before the completion of the first year of dentition. The antrum develops downward and backward during the dentition of the permanent teeth, thus rotating the upper molars into the alveolar process. An arrest of development at this period would delay the eruption of the third upper molar, and it is the most important factor in producing failure of the wisdom teeth to erupt.

Any surgical attack in the canine fossa of the maxillary sinus of the child incurs the risk of injuring or destroying future teeth. The floor of the antrum is above the level of the floor of the nose until puberty, and with the completion of permanent dentition it descends below this level. In some instances pneumatization extends anteriorly and inferiorly to a position above the canine tooth. If

the pneumatization of the antrum is arrested on one side, the wall of the canine socket will be diploic at its base. This cancellous bone readily becomes the site of osteomyelitis when exposed to infection.

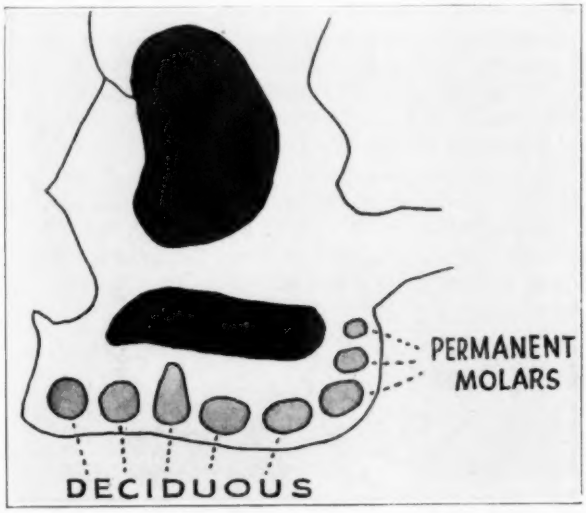

Fig. 2—Relation of the deciduous teeth and the invisible buds of the permanent molars to the antrum at the age of 5 months.

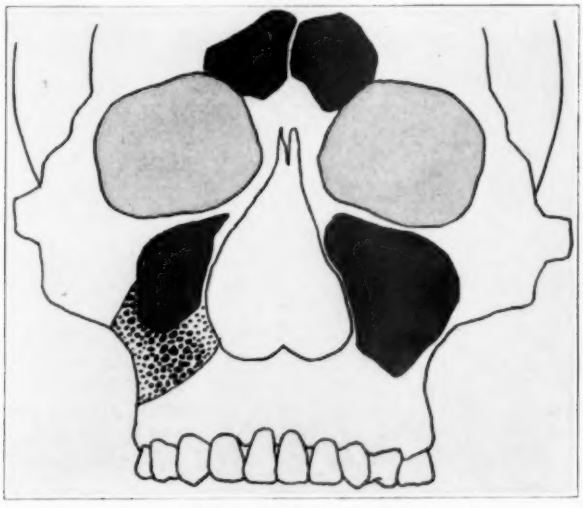

Fig. 3.—Distribution of diploic bone about a persistent infantile antrum.

The anterior and lateral walls, being thinner than the malar process, are readily fractured by blows the force of which is exerted on the malar region. These deformities are visible in roentgenograms in such cases and require replacement of the distorted walls, as they interfere with correct biting.

ETHMOID SINUS

A correct interpretation of the distribution of the cells of the ethmoid sinus is necessary in any surgical attack on this labyrinth. Genetically, the cells develop as an anterior and a posterior group. The anterior cells develop by an evagination below the attachment of the middle concha, whereas the posterior group evaginates superiorly. The most posterior ethmoid cell frequently develops dorsally until a portion of it lies superior to the ventral wall of the sphenoid sinus. The lower cells of the posterior group may extend beneath the orbit and above the posterior wall of the antrum. In a roentgenogram taken postero-anteriorly the shadow cast by these cells is visible in the upper antral space, and in the negative it stands out in bold relief.

SPHENOID SINUS

The sphenoid sinus is the first to become completely pneumatized, and it is capable of extensive development. Infection after the removal of a part or the whole of the anterior wall will stimulate osteogenesis, which may obliterate the cavity of this sinus. When a pathologic condition occurs, subsequent sphenoiditis is really osteomyelitis and is difficult to treat.

PERSISTENT INFANTILE TYPE OF SINUS

The noncellular mastoid process has a prototype in the persistent infantile type of sinuses. A single severe infection or multiple mild infections may arrest the growth and leave for adult life sinuses which lack the degree of resistance necessary for health. A roentgenogram in a typical case will show the frontal sinuses absent or rudimentary, the ethmoid sinuses small with thick walls, the floor of the antrum above or on the level of that of the nose and the sphenoid sinuses small and likewise thick-walled. The clinical course of infection of these dwarfed sinuses is toward chronicity, and postoperative healing is slow.

CONCLUSIONS

The clinical application of the morphologic relations of the sinuses requires comprehensive knowledge of their normal development.

This knowledge assists in the differential diagnosis of acute sinusitis and an exacerbation of chronic sinusitis, especially in children after arrested development of the sinuses.

An infection which has arrested the growth of a sinus cannot be considered eradicated until pneumatization has been reestablished.

TREATMENT OF NASAL HEMORRHAGES BY THE USE OF SCLEROSING SOLUTIONS

LAFAYETTE P. MONSON, M.D., SAN FRANCISCO

Most cases of epistaxis are caused by a rupture of a small blood vessel in the vascular area in the lower anterior portion of the septum, sometimes known as Kiesselbach's area. Here, because of trauma (digital scratching, external trauma or too forceful blowing of the nose) or because of certain constitutional disorders, i. e., infectious diseases, hypertension, local inflammation, drug poisoning, vicarious menstruation, etc., bleeding may occur.

From the Ear, Nose and Throat Department, Greens' Eye Hospital.

In all cases a careful history should be taken. The possibility of a constitutional disorder must be considered and, when found, corrected, if possible.

The commonest methods heretofore used to stop bleeding in this region have been the use of nasal packing, the use of chemical caustics, such as chromic acid or tri-chloracetic acid, and actual cautery.

Recently, I [1] reported the use of sclerosing solutions in cases of various types of hypertrophy of the inferior turbinate in which other nonsurgical types of treatment had failed. I have also enjoyed considerable success in the treatment of hemorrhages of the vascular region in the lower anterior portion of the septum by the use of sclerosing solutions.

The use of sclerosing solutions for obliterating troublesome varices in different parts of the body has been known and applied therapeutically for several years. When small veins are to be obliterated, the solution is injected extravascularly. If small amounts are used, periphlebitis and endophlebitis result. When too large amounts of the solution are used, a slough is likely to form.

My method for treating septal hemorrhages is as follows: A pledget of cotton saturated with a solution of cocaine and epinephrine (equal parts of 10 per cent cocaine hydrochloride and 1:1,000 epinephrine) is applied to the bleeding area until anesthesia and blanching have occurred. After removing the cotton, I inject small doses (approximately 0.1 cc.) of a saturated solution (16.6 per cent) of quinine lactate into each of four or five points beneath the mucosa surrounding the bleeding point. The solution is injected into the extravascular tissues and not into the vessels themselves.

Immediately afterward, a small amount of bleeding usually occurs at the site of each injection. This is controlled by inserting a pledget of cotton into the anterior nares. When treated in this manner it is unnecessary to cauterize the ulcerated, bleeding area. If left alone, this point will heal without any medication. For several days afterward I usually prescribe a bland ointment in order to prevent the formation of crusts until healing has occurred.

For the first forty-eight hours the mucous membrane over the injected area becomes very swollen. On the third to the fifth day the mucosa becomes paler, the swelling subsides and the small vessels seen previously are not visible. Occasionally, it may be necessary to repeat the procedure.

I prefer this method to any other because, in addition to controlling the bleeding, the nearby vessels in Kiesselbach's area are destroyed by the action of the sclerosing solution, and the likelihood of future hemorrhages lessened or eliminated.

450 Sutter Street.

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1. Monson, Lafayette P.: Treatment of Hypertrophied Inferior Turbinate by Use of Sclerosing Solutions, Arch. Otolaryng. **22**:96 (July) 1935.

Abstracts from Current Literature

Ear

MIDDLE EAR PRESSURE AND AUDITORY ACUITY. EVA THOMPSON, HOWARD A. HOWE and WALTER HUGHSON, Am. J. Physiol. **110**: 312 (Dec.) 1934.

Experiments indicate that occlusion of the eustachian tube does not change pressure relations in the middle ear sufficiently to impair hearing. It would seem more likely that actual damage of some sort must be done to the conducting mechanism of the ear as a result of such occlusion.

NOURSE, Cleveland. [AM. J. DIS. CHILD.]

THROMBOSIS OF THE SIGMOID OR LATERAL SINUS; REPORT OF THIRTY CASES. J. LEWIS DILL and S. J. CROWE, Arch. Surg. **29**: 705 (Nov.) 1934.

Sixteen cases of the thirty cases reported were in children under 14 years of age. The syndrome of chills, a septic temperature and a positive blood culture was not always present. One of these symptoms might be absent. Only 20 per cent of the patients had the complete syndrome. The hemolytic streptococcus was found in 50 per cent of the blood cultures taken.

Dill and Crowe state that the temperature may remain elevated for as long as a week following operation. Persistence of the chills after operation usually indicates a complication such as pneumonia, abscess of the hip or involvement of the sternoclavicular joint. Transfusions were considered the best therapeutic procedure. There was a mortality of 33 per cent.

KAISER, Rochester, N. Y. [AM. J. DIS. CHILD.]

THE DEVELOPMENT OF THE NUCLEI AND TRACTS RELATED TO THE ACOUSTIC NERVE IN THE PIG. RALPH F. SHANER, J. Comp. Neurol. **60**: 5 (Aug.) 1934.

This is a study of the development of the nuclei and tracts of the acoustic nerve as seen in pig embryos impregnated by silver methods or stained by cytologic methods. About 150 serially sectioned preparations were available. A general sensory nucleus for the fifth, seventh and eight nerves is recognized in 16 mm. embryos. This breaks up into sensory nuclei for the spinal tracts of the vestibular and trigeminal nerves and for the tractus solitarius in a 24 mm. embryo. The cochlear nuclei are derived from the rhombic lip, which begins a striking proliferation in 16 mm. embryos and forms a thick stratum. The ventral cochlear nucleus is delimited in the 35 mm. embryo. The dorsal nucleus grows to a larger size and differentiates somewhat later than the ventral nucleus. The other nuclei of the acoustic system differentiate in situ out of the reticular substance. The superior olive appears when the embryo reaches the 24 mm. stage and the accessory olive, when it reaches the 100 mm. stage. At 150 mm. all the nuclei have adult cell characteristics. The primitive acoustic nerve is entirely vestibular and is seen in an 11 mm. embryo. Ipsilateral and contralateral secondary neurons of the vestibular nucleus are also seen. In 18 mm. embryos the semicircular canals differentiate. One full turn of the cochlea has grown in 30 mm. embryos. The cerebellum is growing rapidly. The ventral cochlear system of trapezoid fibers appears simultaneously with the cochlear nerve and nuclei. The acoustic striae appear later.

ADDISON, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

VITAL FUNCTION STUDIES: XII. ANALYSIS OF A GROUP OF CHILDREN WITH IMPAIRED HEARING. ALLAN WINTER ROWE, New England J. Med. **211**: 954 (Nov. 22) 1934.

In a previous communication Rowe and Drury summarized the results of a community child study based initially on the analysis of the individual aural acuity. Papers reporting the details of the initial study with the 4-A audiometer; the

individual examination of all those with apparent impairment, as indicated by the first test, and the individual psychometric study of the group proved by the second study actually to be hard of hearing are in preparation. This communication deals specifically with the small group in whom hardness of hearing was demonstrated, in some cases complicated by mental retardation or inferiority and in which no direct etiologic factor was immediately demonstrable. This small group was studied intensively, and the results of the investigation are given in the body of the present paper.

The general course of the investigation, with the numerical partition of the several subgroups, is shown most compactly in tabular form.

Eighty-six children were chosen from a group of more than 2,000 on the basis of a loss of aural acuity without immediate demonstrable physical cause. Thorough study of one half of this group (the remainder being unavailable) demonstrated a tangible pathologic state in every case. Injury to the central nervous system from trauma or disease is the condition in the largest single group, with endocrine disorders involving either the pituitary or the thyroid a close second. The details of the clinical and laboratory examinations are reported and discussed.

GENGENBACH, Denver. [AM. J. DIS. CHILD.]

THE PREVENTION OF HARD OF HEARING. FREDERICK J. O'CONNOR, New York State J. Med. **34:** 771 (Sept. 1) 1934.

This is a discussion of the prevention of deafness in the school and preschool child. Politzer inflation may with advantage be given two or three times after colds in the head to relieve the sensation of fulness. More destruction may occur in ears that recover without being opened than in those in which incision is made. Catarrhal and simple forms of otitis media are probably a greater cause of impaired hearing later in life than is suppurative otitis.

AIKMAN, Rochester, N. Y. [AM. J. DIS. CHILD.]

LATERAL SINUS THROMBOSIS COMPLICATING ACUTE MASTOIDITIS. AUSTIN G. DUNN and WAYNE F. COWAN, Wisconsin M. J. **33:** 836 (Nov.) 1934.

A review of the literature indicates that sinus thrombosis occurs three times more frequently in children than in adults and doubly as frequently in males as in females. Its greater frequency on the right side is considered due to the greater volume of blood returning through the right jugular vein from the brain cavity.

A chill is often the first symptom noted, and tenderness behind the mastoid bone and extending down the sternocleidomastoid muscle is characteristic. A pathologic condition of the fundus is sometimes noted.

The treatment is always surgical. Transfusions of whole blood are beneficial, and in a case reported one donor's blood was especially beneficial.

JANNEY, Wauwatosa, Wis. [AM. J. DIS. CHILD.]

AN ANALYSIS OF OVER FOUR THOUSAND CASES OF EDUCATIONAL DEAFNESS STUDIED DURING THE PAST TWENTY-FIVE YEARS. MACLEOD YEARSLEY, Brit. J. Child. Dis. **31:** 272 (Oct.-Dec.) 1934.

In this second instalment of the article Yearsley considers the subject of acquired deafness and tabulates his 382 cases as follows:

	Boys	Girls	Total
Cerebral infantile paralysis	1	0	1
Hydrocephalus	4	2	6
Epidemic cerebrospinal meningitis	26	24	50
Influenzal meningitis	4	3	7
Measles	23	13	36
Scarlet fever	3	3	6
Pneumonia	12	10	22
Endocarditis	0	1	1
Traumatic	21	17	38
Causes not ascertained	120	95	215

Fifty patients owed their deafness to cerebrospinal fever; forty-three of these were totally deaf.

It is interesting to note that the author reports seven cases of influenzal meningitis, in all of which the patients apparently survived the illness but were totally deaf. No bacteriologic observations are cited.

Diphtheria, varicella, pertussis and influenza are causes of deafness following suppurative otitis. Mumps is not a common cause, and when deafness does occur as a result it is usually due to labyrinthine involvement.

LANGMANN, New York. [AM. J. DIS. CHILD.]

AN ANALYSIS OF OVER FOUR THOUSAND CASES OF EDUCATIONAL DEAFNESS STUDIED DURING THE PAST TWENTY-FIVE YEARS. MACLEOD YEARSLEY, Brit. J. Child. Dis. **32**: 21 (Jan.-March) 1935.

Under the heading "Acquired Deafness" Yearsley first takes up the subject of congenital syphilis. He attributes the decline in the percentage of persons with congenital syphilis in schools for the deaf since 1923 to better and more universal antisyphilitic treatment.

A total of 187 children were studied, of whom 66 were boys and 121 girls. The age of onset of the deafness varied between 6 and 14 years but may be as early as 3 years. The degree of deafness among children with congenital syphilis is usually very serious, and the condition does not appear to be amenable to antisyphilitic treatment of any kind.

Among the concurrent complications found, those of the eye ranked high, interstitial keratitis being present in 177 cases. One hundred and seven children had teeth that were definitely hutchinsonian, excited suspicion or showed caries of the first molars.

Catarrh of the middle ear, suppuration of the middle ear and otosclerosis accounted for 1,438 cases of educational deafness, and injuries of the ear, for 139 cases.

LANGMANN, New York. [AM. J. DIS. CHILD.]

THE "WEVER AND BRAY PHENOMENON": A STUDY OF THE ELECTRICAL RESPONSE IN THE COCHLEA WITH ESPECIAL REFERENCE TO ITS ORIGIN. C. S. HALLPIKE and A. F. RAWDON-SMITH, J. Physiol. **81**: 395 (June) 1934.

The experimental work described in this paper has been directed toward the solution of the problem of the origin of the cochlear effect. Hallpike and Rawdon-Smith have succeeded in confirming Adrian's suggestion that the abolition of the response in the auditory nerve consequent on its section is due to concomitant interruption of the vascular supply of the internal ear. It is possible in favorable preparations to divide the nerve without significant injury to the internal auditory artery, this lying in a well defined connective tissue strand anterior to the nerve. If this is done, the response from the central end of the cut nerve persists but disappears promptly when the vascular strand is divided.

The authors next studied the relative amplitude of the potentials developed in response to tones of high and low frequency, between an indifferent electrode in the muscles of the neck and a differentiated electrode making contact with (*a*) various points on the surface of the cochlea and (*b*) various points within the cochlea. The evidence adduced indicates, first, the good electrical insulating properties of the bony capsule of the internal ear and, second, that the responses from the apical and basal parts of the interior of the cochlea show marked differentiation for frequency, the low tone response being accentuated at the apex and the high tone response at the base. This is considered by Hallpike and Rawdon-Smith to constitute strong evidence of a direct nature in favor of the hypothesis that the cochlear elements are differentially tuned.

Although none of the evidence derived from these experiments is considered decisive in assigning to the cochlear effect a neural or non-neural origin, the authors believe the balance of the evidence favors a non-neural hypothesis.

ALPERS, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

OTITIS OF INFANTS AND THE RELATION BETWEEN OTITIS AND INTOXICATION. M. LITSCHKUS, München. med. Wchnschr. **81**: 1492 (Sept. 28) 1934.

Otitis occurs frequently in infants and often is not diagnosed. In every obscure febrile disturbance the ears should be carefully examined. Likewise, in intestinal disturbances which are not due to faulty nutrition, otoscopy is essential. One must

recognize that there is a relation between intestinal intoxication of nonalimentary character and purulent otitis media, and in the majority of cases the otitis is the primary disorder. It is desirable for every pediatrician to master the technic of otoscopy. (The article comes from Russia.)

BRAHDY, Mount Vernon, N. Y. [AM. J. DIS. CHILD.]

HISTOPATHOLOGY OF LATENT OTITIS IN INFANTS. G. C. BILINKIS and G. E. NEYBURG, Sovet. pediat., no. 2, 1934, p. 14.

Latent otitis in infants is not a simple empyema due to mechanical introduction of nasopharyngeal mucus into the ear. The purulent exudate is the product of inflammation of the mucous membrane and arises locally. It is a focal infection and may be the source of a basic infection of the whole body.

The histologic changes are similar to those noted in otitis in older children. The most frequent organism is the diplococcus (in 70 per cent of the cases). The absence of symptoms during the course of otitis is unexplained.

SEMENENKO-MCKHANN, Boston. [AM. J. DIS. CHILD.]

Pharynx

SEPTICEMIA FOLLOWING TONSILLECTOMY. BRANFORD MORGAN, Brit. M. J. **2**:1145 (Dec. 22) 1934.

Tonsillectomy has been looked on as a relatively minor operation. Morgan, however, is rather disconcerted that there should be even the amount of mortality that there is. He compares the mortality for patients operated on in the hospital who remain there only one night with that for those operated on in the home. Statistics are in favor of operation in the home. He admonishes operators to keep patients in the hospital, when they operate there, from three to five days.

ROYSTER, University, Va. [AM. J. DIS. CHILD.]

Larynx

CONGENITAL CYST OF THE LARYNX. VINCENT E. FISCHER, J. Pediat. **5**:491 (Oct.) 1934.

An infant 2 months old was admitted to the hospital with a history of difficult breathing, inspiratory stridor and cyanosis during crying, since birth. The child was in a state of alkalosis, presumably from hyperventilation. Bronchosocopy and tracheotomy were performed, but the child died six days later. Autopsy clinched the diagnosis of cyst of the larynx. The question arises as to how often congenital cyst has been mistakenly diagnosed as enlarged thymus or cardiac or respiratory disease.

LEMASTER, Evanston, Ill. [AM. J. DIS. CHILD.]

Nose

FACIAL AND DENTAL DEFORMITIES DUE TO PERENNIAL NASAL ALLERGY IN CHILDHOOD. RALPH BOWEN and RAY M. BALYEAT, South. M. J. **27**:933 (Nov.) 1934.

Bowen and Balyeat conclude that facial deformity is common in children who suffer from chronic nasal allergy. Nose-rubbing and nose-wrinkling in children might be considered a pathognomonic sign of nasal allergy. Excessive overriding of the supper incisors and V-shaped palate occur in about 5 per cent of the child population. The occurrence of the deformity is four or five times greater in children who suffer from chronic nasal allergy. The two most probable causes of the palatal-dental deformity are: *(a)* inheritance; *(b)* some type of pathologic condition in infants and children that interferes with the normal development of the paranasal sinuses.

It is still to be proved that there is any significant correlation between the presence of adenoids and the incidence of palatal-dental deformity. It appears that chronic nasal allergy occurring during the age of development of the paranasal sinuses, associated with mouth breathing, is an etiologic factor in cases of excessive overriding upper incisors and the Gothic arch. Heredity must be considered as an important causative factor in all types of malocclusion.

As a means of preventing the deformity of the dental arch the cause of chronic nasal allergy in infants and young children should be found and eliminated. Some of the poor results obtained by the orthodontist may be due to the presence of nasal allergy while the corrective work is being done.

SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

SINUSITIS IN CHILDREN. C. CANTOR, M. J. Australia **1**:13 (Jan. 5) 1935.

In the examination of one hundred consecutive patients with new cases of sinusitis in the clinic for diseases of the ear, nose and throat at the Children's Hospital, Melbourne, 67 per cent were found to have sinus infection. In 44 per cent of these the condition occurred as sinusitis alone, and in 56 per cent it was associated with some other condition, such as enlarged tonsils and adenoids, otitis media and asthma.

The most common symptoms are constant nasal discharge and nasal obstruction. Such symptoms are frequently attributed to hypertrophied and diseased tonsils and adenoids, and the child is subjected to tonsillectomy and adenoidectomy, without benefit. Chronic cough is an occasional chief complaint. Examination shows a mucopurulent discharge on both sides, swelling and edema of the inferior turbinate bones, reddening and thickening of the mucosa of the middle meatus, crusting in the nose and a mucopurulent discharge on the posterior pharyngeal wall. The tonsils are more often normal than not. The adenoids in a majority of cases are not enlarged (this was true for 87 per cent in this series).

Of the aids to diagnosis, roentgenography, transillumination and proof puncture and washing out of the antrum, the latter constitutes the only certain method of diagnosis. Regarding adenoids as an etiologic factor, it may be said: (1) that they may predispose to and cause sinus infection; (2) that they are often coincident with or dependent on sinus infection; (3) that frequently they have no association with sinus infection.

Complications consist of otitis media, recurring sore throat, laryngitis, bronchitis, bronchiectasis, cervical adenitis, malnutrition and anemia. Orbital cellulitis and abscess sometimes follow infections of the ethmoid sinuses.

A fact not sufficiently well realized in sinus infection in children is the high degree of infectivity of the condition.

Treatment resolves itself into: (1) local treatment, which includes puncture and washing out of the antrum in a majority of cases (often five or six washings at weekly intervals); (2) general treatment whereby the nutritional state of the body is raised to a maximum.

GONCE, Madison, Wis. [AM. J. DIS. CHILD.]

Miscellaneous

THERAPEUTIC USE OF CONCENTRATED STREPTOCOCCUS SERUM OF THE NEW YORK STATE DEPARTMENT OF HEALTH IN PATIENTS WITH INFECTIONS OF THE EAR, NOSE AND THROAT. ADELE E. SHEPLAR, MARTHA JANE SPENCE and WARD J. MACNEAL, Arch. Surg. **30**: 1 (Jan.) 1935.

The authors report on the use of streptococcic serum in eight cases of virulent streptococcic infection of the ear, nose and throat. Six of these patients had positive blood cultures. There were two deaths and six recoveries. In view of the favorable results noted in this series, the use of concentrated streptococcic serum is advocated in the treatment of streptococcic infections of the respiratory tract, ear and mastoid, as well as in that of infections of the blood stream developing as sequelae to these.

KAISER, Rochester, N. Y. [AM. J. DIS. CHILD.]

THE ESOPHAGEAL LESIONS ENCOUNTERED IN CASES OF DYSPHAGIA WITH ANEMIA. J. MCGIBBON, J. Laryng. & Otol. **50**:329 (May) 1935.

McGibbon gives a survey of the literature on the group of symptoms known as the Plummer-Vinson syndrome. This syndrome is characterized by the occurrence of glossitis, stomatitis, atrophic pharyngitis and dysphagia with anemia. In most cases the anemia is of a secondary type, although a few cases have been reported

of dysphagia in the course of pernicious anemia. Following the review of the literature, McGibbon describes seven cases. In six of these there were definite organic esophageal lesions; the seventh, although not directly examined, is described as an example of transformation from the usual simple stomatitis to multiple malignant new growths of the buccal mucosa. In every case examined there was definite evidence of chronic esophagitis above the lesion. The pathologic changes in this disease are unknown, and in spite of the most careful questioning it is almost impossible to obtain accurate information from patients as to whether the dysphagia preceded the anemia or vice versa. Some authors have suggested that the dysphagia is the earlier symptom, whereas others have regarded it as a late development. Witts stated that the symptoms appear simultaneously. It is certainly an attractive hypothesis that the anemia is secondary to dietary restrictions consequent on the dysphagia. Support is lent to this possibility by the results of experimental work performed by Miller and Rhoads on dogs, which were fed on diets partially deficient in vitamin B. In many of these animals stomatitis, glossitis, anemia and gastrointestinal disorders developed. The diet given was low in protein and high in carbohydrate and fat. This is the character of the diets which it is customary to find that patients suffering from Plummer-Vinson syndrome have been taking over a prolonged period. Hutter, Middleton and Steenbock produced similar symptoms in rats with a diet partially deficient in vitamin B. There is also abundant evidence that a permanent cure can be brought about by dilation of the esophageal entrance and the administration of large doses of iron together with a well balanced diet. Numerous observers are agreed that the local exciting cause of the esophageal lesion is infection by streptococci, and Witts stated that the patients show a lack of resistance to organisms of the mouth and that recurrent erythematous and herpetiform eruptions of the mouth and tongue are common. It is possible that similar mucosal changes occur throughout the entire digestive tract. It is agreed that achlorhydria may or may not be present. Witts does not consider that the symptoms are due to achlorhydria, but that when achlorhydria occurs it is due to gastritis which, in turn, may be one of the manifestations of the disease. It is conceivable that with simple mucosal lesions of the upper part of the esophagus spasm is first produced. If this is followed by ulceration, webs and bands may be formed in the process of healing. If the infection reaches the submucosal layer round cell infiltration will occur, and organic stricture of the esophagus will then be inevitable. Malignant transformation has occurred in the course of the stomatitis, and it is probable that similar changes may occur in the esophagus. It seems that the esophageal lesions may be regarded as manifestations of a disease of which Witts said that the underlying cause is a digestive or nutritional defect, and that its preponderance in women is probably due to the demands made by pregnancy and menstruation.

EDITOR'S ABSTRACT.

RARE CASES OF TRACHEAL STENOSIS IN CHILDHOOD. PAUL WIDOWITZ, Arch. f. Kinderh. **103:** 80, 1934.

Three unusual instances of stenosis of the trachea in children are described. In "stridor congenitus fugax" pressure on the trachea is produced by edema of the soft tissues on the anterior surface of the neck, caused by birth of the child with the head deflexed. The swelling subsides in a few days. This type of tracheal obstruction is rarely seen, because birth with the head deflexed is usually impossible. "Laryngospasmus spurius" is due to collapse of the tracheal walls in small infants in whom the cartilaginous tracheal rings are usually soft, weak and elastic. The third rare type of tracheal stenosis described by the author was due to torticollis.

LEMASTER, Evanston, Ill. [AM. J. DIS. CHILD.]

DOES THE PRESENCE OF DIPHTHERIA BACILLI IN THE NOSE AND AUDITORY MEATUS INVOLVE DANGER OF INFECTION FOR PERSONS IN THE ENVIRONMENT OF THE BACILLUS CARRIER? T. HÜNERMANN, München. med. Wchnschr. **81:** 1661 (Oct. 26) 1934.

Hünermann answers his question in the negative. Diphtheria bacilli can be isolated from the nasal secretions of patients with atrophic rhinitis, ozena and

dry mucous membranes with crusting. The bacilli are frequently virulent. The same observations can be made in patients with chronic eczema of the auditory canal. Clinical observations indicate that these patients are not a source of infection. They are not comparable with patients who have recently recovered from an attack of acute diphtheria.

BRAHDY, Mount Vernon, N. Y. [AM. J. DIS. CHILD.]

THERAPEUTIC VALUE OF A GOLD PREPARATION. K. H. WAESER, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:75 (June) 1935.

Waeser reports his experiences with a new preparation that contains gold in the concentration of 12 per cent. The therapeutically active agent is a derivative of a sulfur protein obtained from the keratin of skin and supporting tissue. The gold is bound so securely that it cannot be separated with ordinary methods. It may therefore be expected that in the organism the gold will be released slowly and thus cause no toxic effects. In experiments on animals the preparation proved to have rather low toxicity. This and the fact that several other investigators had used the preparation with success in severe wound infections and in infectious arthritis induced Waeser to employ it in the treatment of otorhinolaryngologic disorders. So far, he has employed it in twenty-two patients. In some patients the total dose amounted to 7.6 Gm. (0.91 Gm. of gold). In cases of acute infection the initial dose was usually 0.5 Gm., which on the following or the second day after was increased to 1 Gm., whereas in those of chronic infection 0.1 Gm. was given as the initial dose, which at two or three day intervals was increased by 0.1 Gm. After several hours, the injection was usually followed by a slight increase in temperature. Intravenous injection even occasioned a slight chill. Waeser employed the preparation in the treatment of erysipelas, complications after otitis, particularly meningitis, acute inflammation in the neck, acute angina with tonsillar abscess, stomatitis and gingivitis (Darier's disease) which had been refractory to all other treatments (one case), and other conditions. He is unable to explain its action but stresses the fact that it causes no injurious effects and produces favorable therapeutic results.

EDITOR'S ABSTRACT.

BRONCHIAL AND TRACHEAL CATHETERIZATION AND ITS CLINICAL APPLICABILITY. P. FRENCKNER, Acta oto-laryng., supp. 20, 1934, p. 1.

Frenckner's procedure of bronchial catheterization is the introduction into an air passage of a flexible or nonflexible tube-shaped instrument and, by means of an air-tight arrangement on its distal portion, to "tampon off" the instrument against the wall of the bronchus so that for diagnostic or therapeutic purposes gaseous or fluid substances can be introduced into or withdrawn from the area supplied by the respiratory passage in question.

The first prerequisite for such a procedure was to produce a practically applicable obturator. The principle of the obturator now in use is as follows: The portion of the instrument which is to make up the obturator is made exactly cylindric over an area of a few centimeters. In the middle of the wall of this portion opens a fine canal which runs in the wall of the instrument and is intended for the inflation of the cap. The rubber cap is made of seamless thin elastic rubber tubing with an inner diameter just large enough to permit the cap to go on over the cylinder. The cap is fixed in position with metal rings from 1 to 2.5 mm. wide and from 0.2 to 0.3 mm. thick, exactly cylindric and of such a size that they can be passed over the rubber cap applied to the cylinder, when the former is greatly stretched, but remain firmly in place pressing the rubber against the cylinder when the tension on the rubber is released.

The instruments are the following: 1. The double bronchoscope which allows the flow of the entire respiratory volume of both lungs simultaneously but separately, each in its own tube, and under conditions as nearly physiologic as possible, that is to say, with the ordinary difference between the internal pulmonary pressure and that of the outer air and with the normal speed. The double bronchoscope con-

sists of five tubes, two for respiratory air, two for illumination arrangements and one for inflation of the rubber caps. Two obturators, one at the distal end and one about 3 inches (about 7.6 cm.) from where the other tube for the respiratory air ends, make possible an air-tight closure around the instrument both in the left main bronchus, where the distal end is introduced, and in the lower portion of the trachea, and thus the respiratory air from the two lungs is obtained separately. 2. The bronchial and tracheal catheters are catheter-shaped instruments provided with obturators. They are introduced through the bronchoscope or laryngoscope with air-tight insertion in the trachea or larger air passages. The tracheal catheter is used in intratracheal narcosis. Bronchial catheters of different sizes can be placed in the larger air passages and are intended for therapeutic or diagnostic purposes to introduce into or withdraw from the lung gaseous substances or simple respiratory air. 3. The tracheal cannula with an obturator is used partly in the same way as the tracheal catheter for positive pressure narcosis or intratracheal artificial breathing and partly in laryngeal operations in order to prevent blood or secretion from entering the trachea. 4. The catheter bronchoscope is to be used for the introduction of the aforementioned catheters or ureteral catheters (for injection of iodized poppy-seed oil 40 per cent) into the bronchi. It consists of a catheter tube, a catheter guide and lighting arrangements. The anterior wall in the catheter tube is made with a slide device which can be drawn out after the introduction of the catheter, thus freeing the latter and allowing the bronchoscope to be removed. 5. The self-illuminating laryngoscope with a slide device on the side is used in the same way for the insertion of tracheal catheters.

Bronchial and tracheal catheterization makes possible (1) bronchospirometry, (2) the simultaneous measurement of the intrapulmonary pressure on each side, (3) the introduction of gaseous therapeutic agents into isolated parts of the lung, (4) intratracheal positive pressure narcosis or artificial respiration and (5) protection in laryngeal operations. In discussing these different functions of his apparatus, Frenckner gives especial attention to intratracheal positive pressure narcosis and artificial respiration. The ventilative effect with the apparatus formerly tried for this procedure was altogether too little. Frenckner's apparatus employs quite different principles. The ventilation can be made as great as desired, and the positive pressure can be varied at will. The working principles are as follows: 1. The driving force is air, oxygen or a narcotic mixture which is delivered under sufficiently high pressure (at least 1 kilogram). 2. The apparatus works automatically, controlled by the pressure conditions of the lung, so that with a closed thorax it follows the normal or accidental variations in the respiratory movements (for instance, coughing), but in unilateral or bilateral opening of the thorax it immediately takes over control of the breathing with a frequency, depth and pressure which can be regulated in every detail. 3. The respiratory air is supplied to the lung in sufficiently large quantities whether the pleural cavity is closed or open.

The gas tank (or other apparatus which supplies the compressed air), the positive pressure apparatus, the tracheal catheter and the lungs form an air-tight closed system within which the air or the gas mixture is introduced or withdrawn from the lung by automatically working valves. The respiratory air is let in until a certain desired pressure is reached in the lung. This maximum pressure closes the inspiratory valve at the same time as the passage for expiration is opened. With closed thorax, expiration proceeds freely; with open thorax, however, it is not desirable that the lung should collapse completely, and the expiratory stream is therefore stopped at a specific predetermined minimum. Following a regulable shorter or longer pause after expiration the inspiratory valves are again opened, and inspiration is started. The basic principle in the automatic working of the apparatus is that within a closed system regulable pressure changes decide the beginning and close of inspiration and expiration. Readjustment from the ordinary pressure and volumes used in positive pressure narcosis (for instance, from 60 to 90 mm. of water) to much higher pressure and variations in volume such as are desirable in resuscitation (for example, inspiration of 300 mm. of water and expiration to zero) is performed instantaneously with a simple turn of the wrist.

Society Transactions

MASSACHUSETTS EYE AND EAR INFIRMARY

EDITED BY R. L. GOODALE, M.D., BOSTON

Regular Weekly Meetings, September, October and November 1935

CHRONIC MASTOIDITIS WITH EXACERBATION AND FACIAL PARALYSIS. DR. H. P. CAHILL, DR. R. L. GOODALE and DR. J. LENTINE.

An 18 year old boy was admitted to the hospital with a history of pain for five days, headache for thirty-six hours and a discharging from the right ear for five years. Five days before admission he had acute pain in the right ear which became progressively worse. Little discharge was noted the day before admission. There was no history of nausea, vomiting or chills. The temperature was 100 F. The patient was very dizzy and restless but responded on being examined. There was tenderness of the right mastoid with slight edema; also, an anterior-superior perforation of the membrana tympani. A horizontal nystagmus to the right was present. A fistula test was negative. He had no neurologic signs at this time. The patient complained of right frontal headache and pain along the neck and in the neck.

That evening he showed beginning stiffness of the neck and a Kernig's sign on the right. The respirations were between 10 and 16 per minute. The white blood cell count was 7,300, with 83 per cent polymorphonuclears and 20 per cent lymphocytes. The ocular fundi were normal. A lumbar puncture showed normal dynamics of the spinal fluid; the cell count was 2. The next day the neurologic signs were unchanged. A caloric test showed normal responses.

DISCUSSION

DR. A. S. MACMILLAN: The x-ray film shows a perfectly normal mastoid on the left side. The mastoid on the right side is much smaller and gives the appearance of an exacerbation of an old chronic process. On this side also there are a few definite cells at one point. There appears to be an area of destruction in the posterior-superior angle.

DR. R. L. GOODALE: A radical mastoidectomy was done on that side and the dura uncovered in an area beginning at the posterior-superior angle and extending forward over the middle ear. The dura appeared normal in color, and there was no bulging. There were no signs of an extradural abscess. The lateral sinus was uncovered for a small area, and it appeared normal. The bone throughout was firm and apparently acutely infected. No pus was found at any point.

Following the operation the neurologic signs cleared up. The facial paralysis is slowly diminishing. The boy is making a good recovery.

DR. H. P. MOSHER: What was the organism?

DR. R. L. GOODALE: No organism was found. No pus was found.

DR. H. P. CAHILL: I encountered a case like this, but the culture showed influenza bacilli. Dr. Goodale was told that the case in which I operated was one of influenza, so he considered the fact that within the last one and a half weeks there were two patients with influenza in the hospital. Their condition had been diagnosed by using Dr. Page's medium. In the cases in which this medium was not tried the patients may have had influenza. The medium was not used in making cultures in this case, which may also have been one of influenza. I feel that one must watch for this disease in all cases of this type.

DR. R. L. GOODALE: One other point—in the cases in which influenza was suspected there was a normal or a low white blood cell count.

DR. F. L. WEILLE: This boy had marked dizziness and apathy with a spinal fluid pressure of only 150, and the fluid contained only 2 cells per cubic millimeter. It seems to me he should have showed a profuse drainage from the ear. He had weakness of the right side of the face along with the tenderness of the right mastoid. The weakness was confined to the lower portion of the face. It was about 1 a. m. when I saw him. I thought it was a central rather than a peripheral type of paralysis.

CHRONIC SUPPURATIVE OTITIS MEDIA ON THE LEFT SIDE (?). MASTOIDITIS. INTRACRANIAL COMPLICATIONS (?). DR. H. P. CAHILL and DR. J. LENTINE.

A 47 year old man was admitted on Oct. 26, 1935, with a chief complaint of severe temporal pain and aural discharge. He had had the discharge for six years. One week before admission he suffered an acute onset of pain in the left ear and temporal headache. There was no nausea, vomiting or vertigo. Examination of the left ear showed a foul discharge and occlusion of the canal by a large polyp. He had no hearing and no caloric response.

On October 30, the day of operation, the temperature rose to 102.5 F. He showed stiffness of the neck and Kernig's sign on the left. A lumbar puncture disclosed an initial spinal fluid pressure of 360; the fluid revealed 1,789 cells per cubic millimeter and turbidity, with no organisms. An x-ray film showed sclerosis of the left mastoid. A radical mastoidectomy was done on the left side. A fistula was found in the horizontal semicircular canal. The antrum was filled with a cholesteatoma. The dura was decompressed and found reddened. Later that evening it was decided to remove the tympanal promontory in order to secure better drainage, but no pus was seen. The next day the temperature was 103.5 F. Kernig's sign and stiffness of the neck were still present, and the patient was irrational at intervals. A second lumbar puncture showed an initial pressure of 300; the fluid contained 1,920 cells per cubic millimeter and was turbid. A culture of material from the mastoid showed Streptococcus mucosus-capsulatus. On the second postoperative day the temperature became normal. Kernig's sign and stiffness of the neck were no longer present. The patient's condition is now very good. A lumbar puncture yesterday showed an initial pressure of 165; the fluid was clear and contained 76 cells per cubic millimeter, 33 of which were lymphocytes.

DISCUSSION

DR. A. S. MACMILLAN: The left mastoid, as shown by the x-ray film, is completely sclerosed, and the right mastoid is small and shows no evidence of trouble.

DR. P. MYSEL: This demonstrates the value of resecting the labyrinth. I feel it would have been safer to respect the labyrinth at the time of the radical mastoidectomy. In latent labyrinthitis or a diffuse manifest labyrinthitis with complete deafness and loss of vestibular reaction and with cells in the spinal fluid, if one is going to do a radical operation, one should go a step further and resect the labyrinth. It is fortunate that the man has done so well. The resection of the labyrinth probably saved his life.

DR. H. P. CAHILL: My postoperative results have been better when I have removed just the promontory and opened the lateral canal. Now the question is whether we should not have opened the vestibule posteriorly enough to drain the ductus endolymphaticus. Even when one removes the labyrinth one has the sac of this duct where it comes from the bone in that area half-way between the lateral sinus and the internal auditory canal. When we have removed a portion of the cochlea also, we have had very good results. It is rather dangerous to open the sac, and it would be hard to select the cases. Now that we have had success in two cases of dead labyrinth in which we have removed the promontory, I think we should continue with this until it is proved that the Neumann operation is the better.

CHRONIC SUPPURATIVE OTITIS MEDIA ON THE LEFT SIDE WITH POLYPUS AND ACUTE LABYRINTHITIS. DR. H. P. CAHILL, DR. R. L. GOODALE and DR. J. LENTINE.

A man 36 years old entered the hospital on Oct. 6, 1935, with a history of sudden onset of dizziness, nausea and vomiting, headache and deep-seated pain in the left ear for twenty-four hours. Four weeks ago the patient underwent a myringotomy at the Boston City Hospital. The ear drained constantly until his admission to the Massachusetts Eye and Ear Infirmary. On examination there was a posterior-superior perforation of the drum, which was red and thickened, and there was a pulsating discharge. Wiping the ear produced vertigo. X-ray films showed sclerosis of both mastoids. A fistula test was negative. There were no neurologic symptoms.

Three days ago the patient became suddenly dizzy, was nauseated and vomited. There was a spontaneous rotatory nystagmus upward and laterally, with a slow component to the left. The right ear drum was retracted, and the left ear showed a nonfetid purulent discharge and a small polyp. On extreme flexion of the neck the patient had occipital pain. There was Romberg swaying to the diseased side. The Oppenheim and Gordon reflexes were positive. Kernig's signs were absent. The tuning fork in the Weber test was heard equally by both ears, and hearing for conversation was limited to that within 1 foot (30.5 cm.) from the left ear. The fields of vision and the ocular fundi were normal. A lumbar puncture showed a normal initial pressure, with a cell count of 497, 95 per cent of which were polymorphonuclears. The white blood cell count was 20,900, 90 per cent of which were polymorphonuclears.

DISCUSSION

DR. R. L. GOODALE: Before the operation I talked this case over with Dr. Cahill, as the patient presented a few puzzling symptoms. There was no question that he had an extension of the pathologic process from the mastoid into the labyrinth or the meninges. At the same time he had a normal temperature and was rational. Because of the findings in the spinal fluid I decided to operate. I used the Hudson hand drill. The cortex was very sclerotic. There were two cells remaining in the mastoid, but in the region of the mastoid a large cholesteatoma cavity was found. This extended upward to the aditus ad antrum, which it apparently had enlarged. I felt it was wiser under the circumstances to remove the bridge to get better drainage from the middle ear. A small amount of dura was exposed, which appeared normal. The lateral sinus was not exposed. I felt it would be better not to subject him to much more, as the pathologic process was still very acute. The wound was not closed posteriorly, as I felt we should have to go in later. An iodoform wick was placed in the cavity.

Yesterday morning, that is, twelve hours after the operation, the patient showed no nystagmus. He had headache; the temperature was a little under 102 F.; the neck was about as stiff as before. The neurologists said that the signs of meningitis might be due to the exposure of the dura. On the other hand, the number of cells in the spinal fluid had risen from 500 to 1,600 per cubic millimeter, and the pressure was 200.

This morning he is conscious; his temperature is 105 F.; his neck is definitely stiff, and he barely responds. The cerebrospinal fluid pressure is over 490; the cell count is 10,280, with 97 per cent polymorphonuclears; the fluid is cloudy and yellow, with no growth. The smear this morning showed Pneumococcus.

DR. H. P. CAHILL: I think there are two things which have to be considered, that is, whether one can rely on a Weber test and conversation. The conversation test is of no value in a diseased ear. The Weber test is of no value. I think in all such cases one ought to make a caloric test; or a pledget of cotton saturated with ether and placed in the area would give a reaction.

On this man, I think we ought to operate. I should go in posteriorly as far as the internal auditory meatus and put a wick in there. There might be a collection of fluid. If there is labyrinthitis, there is no harm in opening up the promontory and draining a fistula just internal to the internal auditory meatus.

Another point to consider—if there is any question of an involvement of the lateral sinus, open the sinus.

DR. L. A. SCHALL: Should one use an intraspinal injection of serum?

DR. H. P. CAHILL: One has everything to gain and nothing to lose.

DR. C. G. PAGE: The spinal fluid smear showed many polymorphonuclears, only two or three of which contained encapsulated organisms. These seemed to be pneumococci, type III.

DR. H. P. CAHILL: In any case of this type one should make the caloric test as a routine.

DR. P. MYSEL: The 20,000 cells in the spinal fluid in the presence of an active labyrinth is important. I think the spinal fluid changes are ever so much more important than the vestibular test. The question of whether there is a dead labyrinth with loss of vestibular irritation is not so imporant as what one finds in the spinal fluid. This man would have had a better chance if he had had a labyrinthectomy at the time of the operation.

DR. H. P. CAHILL: I do not agree with Dr. Mysel. I do not want to operate on a labyrinth unless it is a dead labyrinth. I am not sure that I want to even then. If one operates on a labyrinth that is alive one kills the man. I still believe that the caloric test is the test for cases of this type.

(FURTHER REPORT)

DR. J. LENTINE: Dr. Cahill did a labyrinthectomy on October 9. The patient grew progressively worse and died the next day. No autopsy was obtained. The bacteriologic report on the spinal fluid was that it contained Streptococcus haemolyticus.

DR. H. P. CAHILL: This man at the time of the labyrinthectomy had pus in the spinal fluid. In such a case one has to perform more than the labyrinthectomy; that is, one has to drain the cisterna in the internal auditory meatus. So I removed the bone anterior to the lateral sinus, including, of course, the opening of the saccus endolymphaticus, and separated the dura until I was able to reach the cisterna. I also removed the labyrinth posteriorly on the way. About one half of the way between the sinus and the meatus one comes to the ductus endolymphaticus. In this case there was no abscess of the duct. A small drain was placed in the auditory meatus.

ACUTE MASTOIDITIS WITH COMPLICATIONS. DR. H. P. CAHILL, DR. R. L. GOODALE and DR. J. LENTINE.

A 4½ year old girl was admitted on Sept. 19, 1935. One month previously she had a simple operation on the left mastoid in Springfield, Mass. On admission she showed a discharging postaural wound and paralysis of the sixth and seventh cranial nerves on the left side. The lumbar puncture revealed normal cerebrospinal fluid. The mastoid was operated on again on September 21, and softening of the point angle was found. The point angle was thoroughly curetted, and following the operation the temperature remained normal for five days. The facial and abducens nerves became practically normal. Then the child again began to have a septic temperature—as high as 103 F. One week ago the lateral sinus was to be investigated, but because the temperature became normal operation was deferred. Repeated lumbar punctures and blood cultures gave negative results. The white blood cell count has remained at from 12,000 to 13,000. The temperature remained normal for thirty-six hours and then again began to show a daily rise to 101 and 102 F.

Yesterday the patient was to be operated on, but again, because of a return to a normal temperature and absence of other clinical signs, operation was deferred.

DISCUSSION

DR. A. S. MACMILLAN: This x-ray film shows a fairly normal petrous pyramid on the right side. On the left side the petrous pyramid is extensively

decalcified but without destruction at any point. The outer angle seems to be all right. In all places the mastoid is well cleaned out, though a few cells remain over the petrosal bone, all posterior to the superior semicircular canal.

DR. R. L. GOODALE: One week ago we thought the elevation in temperature was probably due to infection in the lateral sinus. The sinus was to be opened the next day. The white blood cell count has been from 12,000 to 13,000. The child has had no chills. Her temperature has not been over 102 F., and there have been many days when it was normal. In view of the x-ray film and the fact that at the first operation some softening was found in the point angle I feel that there is probably a fistula through the point angle to the petrous apex.

DR. H. P. CAHILL: I feel that we should explore the region posterior to the point angle and see if we can locate a fistula in the point angle.

DR. P. E. MELTZER: Are you anxious about this patient?

DR. H. P. CAHILL: I am because the temperature has been elevated so long. She was operated on first in Springfield and was in the hospital there for twenty days and here for a month. I feel that in dealing with a petrous apex one should proceed as conservatively as one can.

DR. H. P. MOSHER: The duration is rather against an infection of the lateral sinus. One would expect it to be cleared up by this time.

DR. L. A. SCHALL: If you do not find a fistula in the point angle will you elevate the dura?

DR. H. P. CAHILL: I think I should perform a radical mastoidectomy, but that would depend entirely on the anatomy of the mastoid bone. Quite a few are investigating the petrous pyramid without performing a radical operation. One cannot be sure until the pyramid has been entered.

DR. L. A. SCHALL: Do you not think you should expose the mouth of the eustachian tube?

DR. H. P. CAHILL: I should prefer to unless I find a fistula posteriorly.

DR. G. B. FRED: I think you will not find a fistula posteriorly, because it is pretty well cleaned out.

DR. H. P. MOSHER: But it is still possible, is it not?

DR. P. E. MELTZER: Has the middle ear discharged from time to time?

DR. R. L. GOODALE: It seems to be improving but there is still some discharge.

DR. P. E. MELTZER: The pathologic process in the middle ear is resolving. I think that in an involvement of the petrous pyramid the middle ear would not improve. I should leave the petrous pyramid alone and look for something local as the cause. With intermittent 36 hour periods of normal temperature, I think I should.

A TUMOR OF ONE SIDE OF THE PHARYNX ARISING FROM AN ABERRANT VESSEL. DR. L. A. SCHALL and DR. P. S. MERTENS.

A child aged 4 was admitted to the Massachusetts Eye and Ear Infirmary on June 12, 1935. Six days prior to that the child had a sore throat and pain on swallowing. She was treated several days with irrigations, and three days before admission an incision was made in the left side of the pharynx, from which pus with some blood was said to have been obtained. One day prior to admission the child spontaneously had a gush of blood from the mouth and was sent here.

On examination there was a moderate swelling of the left side of the pharynx extending into the nasopharynx and the scar of the old incision. On the sixth day after admission there was again a severe hemorrhage from the wound, necessitating transfusion. The swelling subsided, and the child was discharged the following week with almost no swelling in the side of the pharynx. She was followed in the outpatient department, where the swelling was noted to be gradually

increasing until the time of readmission one week ago, when it filled about one third of the pharynx, extending into the nasopharynx. Mouth breathing to a slight extent at night was the only symptom.

Examination under an anesthetic revealed a diffuse swelling of the side of the pharynx extending into the nasopharynx. It was firm and adherent and seemed encapsulated. There was a pulsation which seemed to be transmitted from below and was definitely nonexpansile. The removal of tissue for a biopsy was felt to be inadvisable. Owing to the seemingly rapid growth of the tumor, operation was done two days later. A needle of large caliber was inserted, but neither blood nor fluid came out. An incision made in the mucous membrane exposed a firm fibrous mass. This was dissected and opened. A large mass of very old blood was seen, in the center of which was a pulsating vessel about 5 mm. in diameter. A specimen was taken from the capsule for biopsy. The mucous membrane was then closed with three catgut sutures.

The evening of the third postoperative day there was a severe hemorrhage of bright red blood from the nose and the mouth. It was controlled with a postnasal plug. The child's condition was good, but a donor of blood was kept at hand. Her blood count was 3,300,000; the hemoglobin, 80 per cent. Her respiration seemed good. She was sitting in bed crying when suddenly there was the most violent hemorrhage imaginable from the mouth, 8 to 10 ounces (227 to 284 cc.) of bright red blood being thrown out within ten seconds. The child dropped as if struck and seemed pulseless. The left common carotid artery was immediately compressed against the vertebra, which seemed to control the violence of the hemorrhage. Suction and all equipment were fortunately at hand. A large sponge was jammed into the pharynx, effectively preventing inspiration of blood. A large curved Mosher breathing tube was passed into the larynx, and the pharynx was packed off around this. Oozing still continued. Finally, with the aid of suction, a bleeding point was found at the junction of the pharynx and nasopharynx. Firm pressure of a tonsil sponge on a curved clamp against this in conjunction with the pressure on the carotid artery stopped the bleeding. The child was very pale and almost pulseless. Arrangements were immediately made for a transfusion, ligation of the left common carotid artery and possibly tracheotomy. Immediately under local anesthesia, the artery was ligated by Dr. Schall, and transfusion of 300 cc. of citrated blood was started. The artery was ligated with heavy silk and a drain inserted. It might be mentioned that in anticipation of possible ligation the artery had been compressed against the vertebra for five minutes every hour for the two previous days. The child was in profound shock. Removal of the postnasal plug and the tonsil sponge was followed by only the slightest ooze of blood, which stopped spontaneously. Measures toward relieving shock were adopted, and the child reacted well in about half an hour, the systolic blood pressure being 100. There was no intracranial disturbance following the ligation. Physiologic solution of sodium chloride was injected for the next four hours.

On the following day the red blood cell count was 4,500,000. A house officer remained in constant attendance for twenty-four hours. There has not been further bleeding or any evidence of neurologic symptoms. There is no tumor visible.

DISCUSSION

DR. H. P. MOSHER: This is a very dramatic case, systematically and well handled.

DR. L. A. SCHALL: There was a child with a large swelling in the posterolateral wall of the pharynx that at the time of operation did not pulsate, that grew rapidly and that appeared to be localized who had survived an incision in June. When the question of differential diagnosis came up, we considered the possibility that an aberrant vessel was present, but the child had lived through a previous incision of this swelling. Dr. Barnes was in the operating room when Dr. Mertens examined the patient under ether, and he felt very strongly that there was a cyst or a rapidly growing tumor. I decided to make an exploration. I made an incision

in the mucous membrane after injecting procaine hydrochloride, and I then discovered a hard fibrous mass, apparently a capsule, which was tightly adherent. My incision was about 1¼ inches (3 cm.) long. I exposed this capsule for a distance of 2 cm. on each side. I had repeatedly aspirated the growth without obtaining either blood or cystic fluid. I decided to take a chance. On cutting into the capsule I found clotted blood, which welled up into my incision. I was careful not to remove it. Then I saw a large vessel. I closed the incision with three sutures.

The child is apparently doing all right. I do not know what this growth is. There was no bruit at the time of operation on it. I believe that at the time of the original incision a vessel was injured and that the extravasation of blood caused a hematoma in back of it.

DR. R. L. GOODALE: Do you think in hindsight you would have tied the carotid artery beforehand?

DR. L. A. SCHALL: I do not know. I have seen cases of tumor in the lateral pharyngeal wall in which the artery was not ligated.

DR. W. B. HOOVER: In a case in which the finding is considered to be an aberrant vessel of the thyroid do you think it is a good idea to make the approach from the outside gland rather than through the pharynx?

DR. L. A. SCHALL: I ruled out the aberrant vessel because there was no pulsation. The mass was repeatedly aspirated without getting anything. If I had known that an aberrant vessel was present I should have ligated the carotid artery. I should not have attempted to operate from the inside.

CARCINOMA OF THE LARYNX TREATED BY LARYNGECTOMY. DR. L. A. SCHALL and DR. P. S. MERTENS.

A man aged 42 was admitted on Oct. 25, 1935, who stated that he had experienced gradually increasing dyspnea for eight months which in the last two months had amounted almost to aphonia. He had consulted many physicians and among other things had had a tonsillectomy two months prior to admission, without relief. Since then he had suffered increasingly frequent pains in his left ear and complete aphonia. Three days before admission severe dyspnea with cyanosis developed, and he was referred here with a diagnosis of carcinoma. He had lost some weight.

On examination the epiglottis seemed normal, but on the left true cord, near the anterior commissure, was a fungating mass, 6 by 8 mm., which partly blocked the airway. The left arytenoid was edematous and partly fixed; the right moved normally. The patient had periods of severe dyspnea with slight cyanosis. No glands were palpable. The Hinton test and examination of the chest gave negative results.

Under local anesthesia, a large part of the mass was removed by direct laryngoscopy by Dr. Fred, with relief of breathing.

DISCUSSION

DR. S. A. MYERS: The pathologic section shows epidermoid carcinoma, grade 2, and is made up of cells of an adult type.

DR. P. S. MERTENS: The patient was given thorough dental and general care before operation and was in excellent condition.

Six days ago a total laryngectomy was done by Dr. Schall. Under tribromethanol in amylene hydrate a bronchoscope was passed and ether given through this as needed. A T-shaped incision was made and the larynx as well as the first four rings of the trachea dissected free, all bleeding vessels being tied. The trachea was cut above the first ring and then dissected upward. A rubber tube the size of the trachea was then inserted into it, preparatory to obtaining further anesthesia. The trachea was packed off from below to prevent secretion from entering the wound. After removal of the thyroid cartilage the mouth was packed with gauze soaked with solution of hexylresorcinol and the epiglottis

was turned into the wound. Dr. Schall removed a large piece of the anterior wall of the esophagus in which there was a suggestion of malignant growth. A nasal feeding tube was inserted. The remainder of the epiglottis was inverted and sutured to the mucous membrane of the mouth with intestinal sutures. The whole wound was painted with a 5 per cent solution of mercurochrome. The fascia and muscles were partially closed over this and the skin closed with silkworm gut sutures. Four rubber drains were inserted through stab incisions made in the skin lateral to the trachea, the trachea being sutured to the skin. The patient was given 2,000 cc. of saline solution and dextrose intravenously. The wound has healed by primary intention in five days. There has been but slight elevation of the temperature, with no cough. The patient's mental condition is excellent. He was out of bed on the second day. There has been no evidence of inflammation or secretion.

Dr. H. P. Mosher: Has Dr. Schall ever dissected the larynx from above down?

Dr. L. A. Schall: I have never removed the larynx from above downward. I used the T-shaped incision, and I removed the pretracheal muscles. By such a course I get a flatter neck. In this case I tried for the first time infiltrating the tracheal wall before cutting, and there was absolutely no bleeding. Although I infiltrated the posterior wall, some bleeding was encountered there.

I had to remove part of the anterior wall of the esophagus. I think the work in this case comes rather close to some of the work on the anterior wall of the esophagus one has read about.

In three cases which I followed with Dr. Barnes, the epiglottis was turned down, the mucous membrane of the anterior surface of the epiglottis being used.

Dr. H. P. Mosher: One has to watch the base of the epiglottis closely, to make sure.

Dr. L. A. Schall: I had recurrences in those three cases. In this case I removed the whole epiglottis.

Foreign Body in the Bronchus. Dr. L. A. Schall, Dr. G. B. Fred and Dr. P. S. Mertens.

A baby 14 months old was seen in the emergency ward six days ago. Five hours before admission he swallowed something which he had pulled out of a wooden box. He coughed up some blood and became cyanotic. The mother stuck her fingers into his throat, but the cough continued. He was croupy. An x-ray film taken at a local hospital disclosed nothing, and the boy was sent here.

On examination his inspirations had a croupy sound and he seemed restless, but there was no cyanosis. The right side of the chest was noted to be less active than the left, and the breath sounds were less noticeable on the right. The larynx could not be seen.

DISCUSSION

Dr. A. S. MacMillan: X-ray films taken at the Massachusetts General Hospital showed very definitely obstructive emphysema of the right lung, leaving the left lung normal. The right lung showed air trapping. The patient was given bronchoscopy within one-half hour after admission, at about 8 p. m.

Dr. G. B. Fred: The foreign body was evidently on the right side. The patient was given ether, and a 5 mm. bronchoscope was introduced. I was unable to pass it between the vocal cords. A 4 mm. bronchoscope was tried, and this was passed with difficulty owing to the thickness of the cords. A foreign body was very easily seen in the right main bronchus. Three attempts were made to take it out, and on the fourth attempt it was removed. I thought that the patient had had enough manipulation, and he was therefore taken from the operating room and put to bed. Fluoroscopy the next day showed both sides of the diaphragm moving perfectly, with air going in and out of both lungs easily.

Dr. H. L. Higgins: When I first saw the child the next morning there was practically no air going in on the right side of the chest. There was breathing

on the left side, which was compensatory and very loud. There was a slight question of dulness on the right side. I could not be sure whether it was hyperresonance or whether it was dulness.

DR. H. P. MOSHER: With obstruction on the right side, the diaphragm should not have moved.

DR. H. L. HIGGINS: I think the facts of the physical examination are: There was very marked suppression of breath sounds on the right, there was accentuation of breath sounds on the left, and there was a question of slight dulness or hyperresonance on the right.

DR. H. P. MOSHER: The point is that there was not complete obstruction, because if there had been the two sides of the diaphragm would not have moved. That deceived the observers. But Dr. Schall introduced the bronchoscope and removed the other half of the vegetable foreign body two days after the original operation.

DR. G. B. FRED: The day after the bronchoscopy, on account of respiratory difficulty, a tracheotomy was done under local anesthesia.

DR. L. A. SCHALL: To emphasize the point in this case I shall refer again to a case in which I operated last year. A tragedy occurred in removing one half of a bean; there was a second half. So I feel it should be an established rule that when one deals with a vegetable foreign body and has to seize the foreign body one should always reintroduce the bronchoscope and look again.

DR. H. G. TOBEY: Do I understand that the x-ray film taken after the first bronchoscopy still showed obstruction?

DR. A. S. MACMILLAN: The x-ray film showed no foreign body, but one half of the foreign body was still there.

DR. H. P. MOSHER: The point is that the stethoscope should show it. It did not. My colleagues and I have been depending on x-ray films.

DR. P. MYSEL: What is the advisability of giving ether in a case of this type?

DR. G. B. FRED: Ether is given on account of the danger of spasm of the larynx when one is removing the foreign body. One might lose it in the larynx.

DR. H. P. MOSHER: In not using ether with a child of this age one doubles the chance of trauma.

DR. H. L. HIGGINS: After Dr. Schall took out the second piece of bean, examination showed signs of suppression of breathing on the left side and some hyperresonance.

DR. L. A. SCHALL: The whole tracheobronchial tree was inflamed. The mucous membrane was edematous. The left main bronchus was also occluded. I got a little bit of the foreign matter into this bronchus. The right main bronchus opened hardly at all. The respiratory condition, I thought, was explained by the inflammatory condition of the mucous membrane of the tracheobronchial tree.

DR. H. P. MOSHER: Vegetable foreign bodies often give a very sharp reaction in the lung and trachea.

MENINGITIS WITH RECOVERY. DR. GEORGE H. POIRIER and DR. BURTON E. LOVESAY.

The child of a graduate nurse, a boy 4½ years of age, had been in good health until one week before admission. Then an infection of the upper respiratory tract developed, and there was a discharge from the ears. On Dec. 2, 1935, he was admitted to the pediatric service of the Massachusetts General Hospital because of the respiratory symptoms and for observation. Within forty-eight hours he was transferred to the Massachusetts Eye and Ear Infirmary.

On examination, six days after the onset, the child appeared to be semicomatose. He had marked rigidity of the neck with a temperature of 103 F. and a profuse discharge from both ears and from the nose. Kernig's sign was present on both sides; the ocular fundi did not reveal any choking of the disks. X-ray

films of the chest showed nothing abnormal, and those of the mastoids showed density but no destruction of cells. Lumbar puncture revealed spinal fluid containing 621 cells per cubic millimeter—95 per cent polymorphonuclears. The manometer showed normal dynamics. Benedict's solution was reduced. The blood showed 31,800 white and 6,190,000 red cells. During the following eight weeks the rigidity of the neck persisted, and twenty lumbar punctures were made. The cell count ranged from 600 to 3,000. Hemolytic streptococci were found twelve times in cultures of the spinal fluid and three times in those of the blood. The urine was essentially normal throughout the illness. The white blood cell count ranged from 13,000 to 36,000. Six weeks after admission 200 cc. of blood was transfused. Choking of the disks appeared about three and a half weeks after the onset and continued for two weeks. The ears discharged for approximately eight weeks.

X-ray films made on admission showed increased density of the mastoids but no destruction of cells. Nine days later there was some decalcification of the right mastoid, but seventeen days later the right mastoid was definitely clearing and the left mastoid had entirely cleared. At the present time the mastoids are normal.

The temperature ranged from 99 to 105.4 F. and during some intervals was of the picket fence type. Following the transfusion of blood the temperature subsided by lysis, and the boy improved rapidly. The rigidity of the neck disappeared, the discharge from the ears diminished and the patient became alert and interested in the events of the ward.

DISCUSSION

DR. GEORGE H. POIRIER: This was a case of acute fulminating infection, hemolytic streptococci being found in the spinal fluid and the blood stream, in which the treatment was symptomatic. Lumbar punctures were done when signs of increased intracranial pressure were present, and blood transfusion, when the blood picture indicated it.

On this service the cases of meningitis are divided into three groups: The first group comprises cases of meningitis associated with acute disease of the ear of several weeks' duration in which there is clinical and roentgenographic evidence of suppurative mastoiditis. In these cases my co-workers and I do a simple mastoidectomy, bare the dura and expose the lateral sinus.

In the second group, comprising cases of meningitis with chronic suppuration of the ear with or without acute exacerbation or cholesteatoma, we do a radical mastoidectomy and make careful search for an extradural abscess or a lead to an abscess of the brain.

In the third group, comprising cases of meningitis with acute disease of the ear or disease of very short duration and no clinical or roentgenographic evidence of mastoiditis, we give symptomatic treatment.

The patient under discussion has been free from fever for four weeks. As far as we can make out, the child is normal mentally and physically. The mother, a graduate nurse, states that the child is normal except, possibly, for a slight change in the tone of his voice.

Book Reviews

Otosclerosis. By Louis K. Guggenheim, M.D., Assistant Professor of Clinical Otolaryngology, Washington University School of Medicine. Price, $6. Pp. 212, with 127 illustrations. Published by Louis K. Guggenheim, St. Louis, 1935.

In this volume Guggenheim brings together the evidence for his regression theory of otosclerosis. This theory is based on four main points: 1. The bilateral symmetrical involvement in otosclerosis speaks for heredity. 2. The areas commonly involved are in intimate relationship to the oval window, round window and cochlea, structures which are recently acquired compared to the utriculus and canals and which are, therefore, more subject to variation. When these structures are involved in otosclerosis the result is strikingly similar to the morphologic features of the lowest vertebrates. Elaborating on this point is an interesting chapter on phylogenesis, tracing the development of the aural capsule from the lowest vertebrates, the cyclostomata (hagfish and lamprey) through the true fish, amphibia, reptiles and birds to mammals. 3. The area of predilection anterior to the oval window near the fissula ante fenestram is almost constantly involved in otosclerosis. The fissula is a vestigial structure, the author believes, originating with the accessory endolymph channel of the shark and ray. The early involvement of this area in otosclerosis seems to substantiate the regressive nature of the process. Whether or not one accepts the theory of regression, the evidence is interesting and is as convincing as for any other theory of otosclerosis thus far advanced. 4. The foot plate of the stapes, derived from the labyrinthine capsule, is involved in otosclerosis, thus obliterating the oval window and reproducing a lower vertebrate morphologic picture, but the crura, derived from Reichert's cartilage, is never involved in otosclerosis, which is further evidence that otosclerosis is essentially a regressive process.

A chapter on ontogenesis traces the embryologic development of the human aural capsule, with attention to the fissula ante fenestram.

Chirurgie de l'oreille, du nez, du pharynx et du larynx. By Georges Laurens. With the collaboration of Maurice Aubry. Third edition, entirely revised. Paper, 130 francs; cloth, 150 francs. Pp. 1,075 with 786 illustrations. Paris: Masson & Cie, 1936.

This profusely illustrated volume clearly sets forth the surgical pathology and the technic of operations performed as the French know so well how to do. Most of the chapters have been rewritten, and a number of new chapters have been added. In the latter the following are discussed: the intracranial complications of otitis media, representing a prolonged study which considers recent methods of exploration and treatment; the surgical treatment of vertigo and of acoustic nerve tumors; comprehensive surgery in cases of cancer; including cases of cancer of the ear, massive involvement of the face, cancer of the pharynx and cancer of the larynx; several technics for thyrotomy and laryngectomy; the surgical treatment for fixation of the vocal cords in the median position, and diverticula of the esophagus.

Directory of Otolaryngologic Societies *

FOREIGN

Collegium Oto-Rhino-Laryngologicum Amicitiæ Sacrum

President: Prof. Gunnar Holmgren, Karolinska Mediko Kirurgiska Institut, Stockholm, Sweden.
Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg, 143 Groningen, The Netherlands.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Ralph A. Fenton, 1020 S. W. Taylor St., Portland, Ore.
Secretary: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
Place: Kansas City, Mo. Time: May 11-15, 1936.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
President-Elect: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: New York. Time: Sept. 26-Oct. 3, 1936.

American Bronchoscopic Society

President: Dr. H. M. Taylor, 111 W. Adams St, Jacksonville, Florida.
Secretary: Dr. Lyman Richards, 319 Longwood Ave., Boston.
Place: Detroit. Time: May 27, 1936.

American Laryngological Association

President: Dr. Burt R. Shurly, 62 W. Adams Ave., Detroit.
Secretary: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Place: Detroit. Time: May 25-27, 1936.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Thomas E. Carmody, Metropolitan Bldg., Denver.
Secretary: Dr. R. L. Loughran, Sharon, Conn.
Place: Brown Palace Hotel, Denver. Time: May 18-20, 1936.

SECTIONS:

Eastern.—Chairman: Dr. Henry B. Orton, 24 Commerce St., Newark, N. J.
Southern.—Chairman: Dr. Robin Harris, Lamar Bldg., Jackson, Miss.
Middle.—Chairman: Dr. W. E. Grove, 324 E. Wisconsin Ave., Milwaukee, Wis.
Mid-Western.—Chairman: Dr. Harry W. Lyman, Carleton Bldg., St. Louis.
Western.—Chairman: Dr. Carroll Smith, Paulsen Bldg., Spokane, Wash.

American Otological Society

President: Dr. Francis R. Packard, 304 S. 19th St., Philadelphia.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.
Place: Detroit. Time: May 28 and 29, 1936.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.